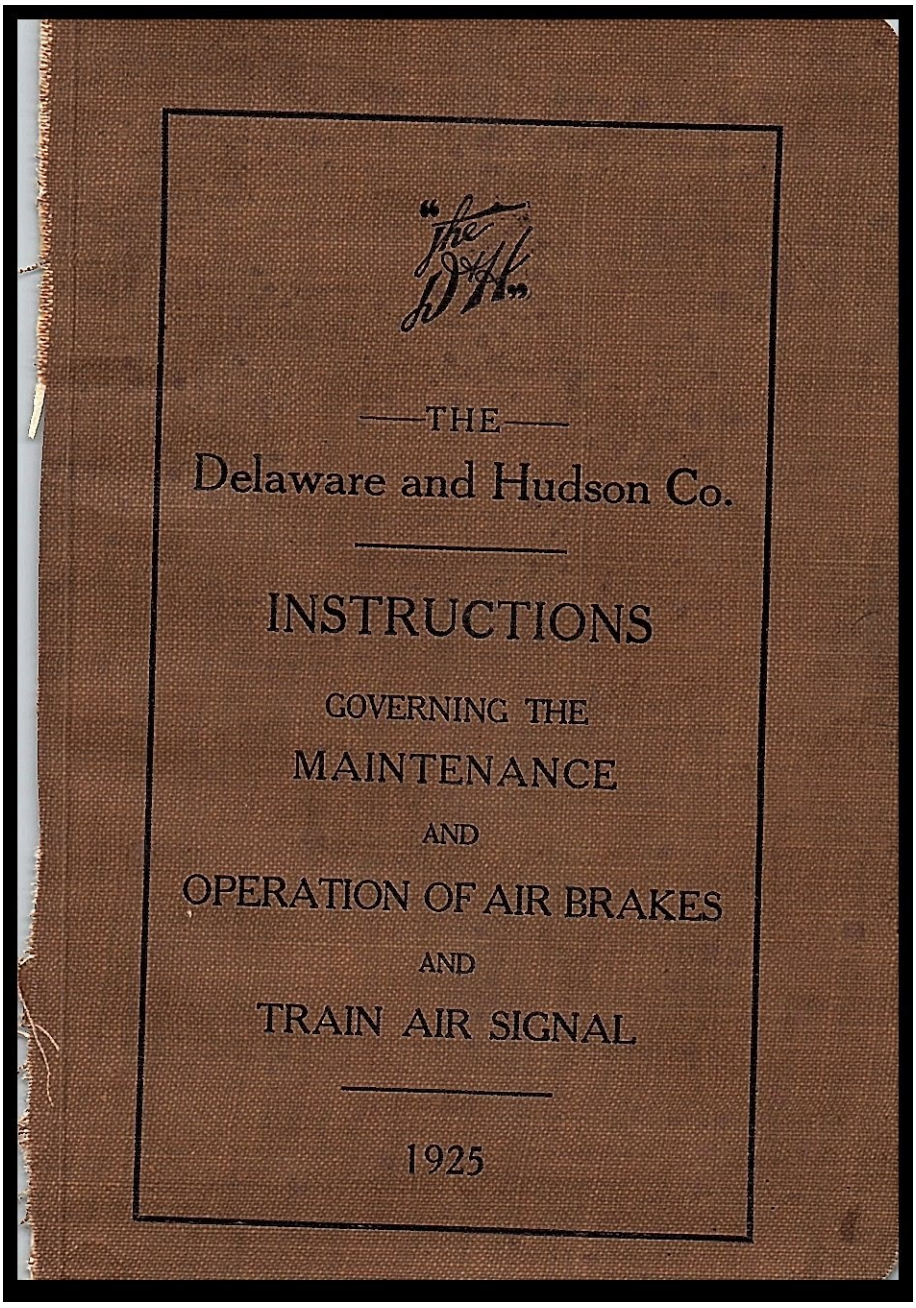
"the D&H"
THE
Delaware and Hudson Co.
INSTRUCTIONS
GOVERNING THE
MAINTENANCE
AND
OPERATION OF AIR BRAKES
AND
TRAIN AIR SIGNAL
1925

No. 2537

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Delaware and Hudson Co.

INSTRUCTIONS

GOVERNING THE

MAINTENANCE

AND

OPERATION OF AIR BRAKES

AND

TRAIN AIR SIGNAL

1925

(Form B-636)

NOTICE

The following instructions are issued for the guidance of all employes whose duties require the manipulations, supervision and maintenance of the Air Brake, and the Train Air Signal Equipment, so as to obtain the greatest efficiency from their use, and to minimize train delay and damage to equipment.

G. S. EDMONDS,
Superintendent of Motive Power.

G. W. DITMORE,
Master Car Builder.

Approved:
H. F. BURCH,
Assistant General Manager.

MARCH 1, 1925

INDEX

GENERAL INSTRUCTIONS

1. *Enginehouse Foremen's Duties:* Enginehouse Foremen must have engine and Tender Air Brake equipment and Train Air Signal apparatus inspected and required repairs made before each trip.

2. *Enginemen Reporting Work:* To ensure the satisfactory operation of the engine brake and signal apparatus and guard against delay caused by failure of same, the incoming engineer should make a thorough inspection, reporting needed repairs, and the outgoing engineer should, before leaving the vicinity of the enginehouse, determine whether the apparatus is in proper condition to make the trip.

2–A. *Enginemen Taking Engine; Inspecting and Testing:* Enginemen on taking the engine, must ascertain by suitable tests and inspection whether the compressor, or compressors, the air gauges, the feed valve, the reducing valve, and brake valves operate properly. Whether the pressure regulations are standard for the required service: Whether the engine and tender brake operate properly, including the correct piston travel: Whether there is any serious air leakage, whether main reservoirs are drained of water: Whether the governor starts and stops the compressor as it should. If any such

device is in a condition that would likely cause danger or greater delay later, do not proceed until this is remedied.

2–B. *Testing for Leaks:* Brake pipe leakage on the locomotive and tender, with automatic brake valve on the lap position, should not exceed 5 pounds in one minute after a 5 pound service reduction.

2–C. *Firemen's Emergency Valve:* On double cab (mother hubbard) locomotives an emergency valve is located on back boiler head within reach of the fireman from the tender deck. This cock is piped direct to the brake pipe and may be opened to apply brakes in case of emergency, and should be known to be in serviceable condition before the locomotive leaves the enginehouse.

3. *Draining and Blowing Out Equipment:* Air compressor drain cocks must be opened and left open while air compressor is shut off. Before leaving house, the main reservoirs must be drained and the brake pipe and signal pipe blown out. Air hose on engine must be blown out, immediately before being coupled to train. Air hose on cars must be shaken (not blown out) to remove dirt or snow from coupling.

4. *Starting and Lubricating Air Compressor:* Before starting an air compressor, care should be taken that all drain cocks are open, always start and run the compressor slowly until it becomes warm and about 40 pounds pressure is obtained in main reservoir, which provides for a cushion in the air cylinder, at which time the drain cocks should be closed.

The maximum speed of an air compressor should not exceed 120 single strokes per minute, except for mountain

grade work. The lubricator should be in operation as soon as possible after starting the compressor so as to thoroughly lubricate the steam cylinders, at which time the oil feed should be adjusted to feed 15 to 20 drops of oil as rapidly as possible; then regulate feed to 2 drops per minute, per single compressor. The New York No. 5, and 8½ Cross Compound compressors should have 3 drops per minute. The Lubricator should be kept in operation while compressor is running. Oil cups on air cylinders must be properly filled with a good grade of valve oil, before leaving enginehouse, and during the run should, if conditions require, be given further attention by the engineer.

5. *Standard Air Pressure:* Air pressure regulating devices on engines and cars must be adjusted for the following standard pressures:

MAIN RESERVOIR

Service	*Type Governor*	*Pressures*
Passenger	Single top	*130
Freight	Single top	110
	Double top — Low	110
	Double top — High	125

*By Special instruction 140 pounds.

BRAKE PIPE

Service	*Pressures*
Passenger	110
Mixed trains i. e., passenger and freight branch lines	90

Service	*Pressures*
Pusher and switching service	70
Freight—Double pressure feed valve	70–*90

* For heavy grade work.

MISCELLANEOUS

	Pressures
Governor valve, water raising system	60
Reducing valve for independent or straight air brake	45
Reducing valve for train air signals	50
Reducing valve for water raising system	20
Reducing valve for high speed brake	*60
Safety valve for straight air brake	50
Safety valve for "ET" distributing valve	68
Safety valve for "PS" "LN" or "UC" passenger brakes	60

* On locomotives 50 pounds.

6. *Terminal Test of Brakes:* Air brake repairmen and inspectors will have full charge of trains while testing and will use blue signals as per Operating Department Rules No. 26. Trains will not under any circumstances, be disturbed while in their charge without obtaining their permission.

6-A. *Yard Test Plant:* When a yard brake test plant is available trains will, where practicable, be so placed when made up, as to permit of its use, and inspectors will use it for charging and testing trains, also, if when the locomotive is ready to couple on have the train

charged, thereby saving time and locomotive compressor labor.

Where no yard plant is available the test will be made from the locomotive. When necessary to use the locomotive, the enginemen and trainmen will see that it is coupled to the train in ample season.

6-B. *Testing Trains Charged from Yard Plant:* When brakes are to be tested from yard plant, after blowing out yard line, couple up and charge to required pressure. During the time the train is being charged, inspectors will examine closely for defects noting carefully whether air hose are coupled properly; angle and cut out cocks open; except angle cock on rear of last car, the position of retaining valves; (handles down) retaining valve pipes and connections. During this examination they will note and stop all brake pipe leaks, also inspect foundation brake gear for defects. After the brakes have been fully charged, a 15 pound service reduction should be made with the inspectors testing device, (this must have an air gauge attached to show the pressure charged to and the amount of the brake pipe reduction made when applying the brakes) with the brakes held applied each car in the train should be carefully examined for defects, whether there be any triple valves that do not operate in service application, whether any brakes leak off due to brake cylinder leakage, incorrect piston travel, those more than 8 inches or less than 6 inches should be marked for adjustment later to 7 inches. Where short piston travel is noted it should be ascertained if brake has not partially leaked off. After making a thorough inspection of

each car in the train, the brakes should be released and a further inspection made to note whether or not all have released. All necessary repairs should be made before the train is allowed to depart. If during the test the brake pipe leakage as indicated by the inspector's test gauge exceeds 6 pounds per minute it must be reduced to 6 pounds or less.

When circumstances will permit the brakes should be kept charged until the road engine couples on. When the road engine couples on a further test must be given to ascertain whether the rear brakes can be applied and released from the locomotive.

7. *Charging Trains with the Locomotive:* Where yard plants are not available, it is then necessary to charge the brakes with the locomotive as follows: Engineman will have maximum main reservoir pressure when coupled to the train; do this by lapping the automatic brake valve sufficiently in advance, and upon the air being cut in move the brake valve handle to full release position and let it remain there until when it is moved to running position, the brake pipe hand on the air gauge indicates within 5 pounds of the pressure carried, wait in running position for 2 minutes, then make a kick-off movement to full release position for 5 seconds, returning brake valve handle to running position.

8. *Signals for Testing Brakes:* Signals to enginemen for testing brakes must be given verbally, by hand, or, with passenger trains, by the train air signal from the forward car to apply, and by the air signal from rear car to release. In the absence of train air signal, hand or

lamp signal must be given. Brakes must not be applied or released during a standing test until proper signal is given.

9. *Time Allowed for Testing Brakes:* Ample time must be allowed to properly inspect and test air brakes in all trains and place them in proper working order before leaving terminal.

10. *Piston Travel:* The piston travel with a full service brake application must be adjusted as follows:

Engine Driver Brake	4 to 6
Engine Tender Brake	6 to 8
Passenger Equipment Cars	6 to 8
Freight Equipment Cars	6 to 8

Before adjusting piston travel or working on brake rigging cut out cock must be closed, and reservoirs bled, except where cock is in the brake cylinder pipe, then this cock only needs to be closed.

11. *Outgoing Brake Test:* Before a train leaves an originating point, where brakes have not been tested from a yard test plant, and a locomotive is used, proceed as follows:

When the air gauge on the locomotive indicates the required 70 pounds standard brake pipe pressure, engineman must on signal, make a service brake pipe reduction of 15 pounds. After the brake pipe discharge ceases, engineman will time brake pipe leakage with his watch, which must not exceed 3 pounds from 55 pounds in one-half minute, then follow by another reduction, making a total of 20 pounds. Inspectors, or train crews, must then make certain that all brakes have applied, that piston

travel is not less than 6 nor more than 8 inches, and that brake rigging does not bind or foul. Inspector or member of train crew must then give engineman proper signal for releasing brakes, and see that all release.

12. *Brake Pipe Leakage:* Freight trains must not leave originating point nor leave terminals where car inspectors are located, and engines are changed, when brake pipe leakage exceeds 6 pounds per minute this following a 15 pound service reduction, from standard brake pipe pressure, with brake valve in lap position.

Note: See paragraph 64, long brake pipe.

13. *Reporting Condition of Brakes:* A defect discovered during a standing test that cannot be repaired promptly, must be reported by inspectors or train men to Car Foreman, or Conductor, who will decide what action is to be taken. At the completion of the test, engineman must be informed by inspector or trainman, of the number of cars in the train, and the condition of brakes. Conductors should also advise enginemen before leaving a terminal point how the train is made up, i. e., whether train consists of all loaded cars, all empties, or, where consisting of both, in what portion of the train the loaded cars are.

14. *Inspection of Hand Brakes and Retaining Valves:* Before a train is started from a terminal the inspectors, or train crews, must know that all hand brakes are released and pressure retaining valve and angle cock handles are in proper position.

15. *Adding Cars to Train:* Where cars are added enroute, make the terminal brake test inspection of such

cars only, but also ensure when the entire train is coupled that the rear brakes will apply and release from the engine in control, as per instructions, paragraph 16.

16. *Road Test:* When locomotives are changed, or an angle cock has been closed for any reason, except for cutting off car or cars from the rear of train, an application and release test of train brakes must be made from the locomotive. This is to determine whether the brake pipe is open from the brake valve on the locomotive to the last brake in the train, and is made, as follows: When the brakes have been charged sufficiently, the engineman will, on signal, make a service reduction of 20 pounds. When trainman or inspector at the rear car sees this brake apply, he will signal to release. The train must not proceed until the engineman is able to release the rear brakes. See paragraph 28-D.

17. *Running Test:* A running test of brakes must be made with passenger trains as soon as speed of train permits, after engines or engine crews have been changed, after angle cocks have been closed, and at a sufficient distance so that train can be stopped by the hand brakes, before reaching ends of double track, junctions, railroad crossings at grade, drawbridges, meeting and passing points and before going down heavy grades. Such test should be made by applying the brakes with sufficient force to ascertain whether they are in working order. Steam should not be shut off when making the test.

18. *Brake Pipe Exhaust:* When making a service application of a given number pounds reduction, the length of the brake pipe exhaust should be noted so that

when making future applications of the same reduction, on this train, it will readily be noted, should an obstruction in the brake pipe occur, or an angle cock be closed on the forward part of the train.

19. *Movement of Cars with Brake Inoperative:* Freight trains leaving an originating point must have all brakes in operation unless otherwise authorized. Car next to engine must have brakes operative. Two or more cars with brakes inoperative must not be placed together.

19-A. The movement of a car with brakes inoperative in passenger, express or milk trains is restricted as follows:

1. From leaving originating point of train.
2. From being placed in train at intermediate terminals.
3. From being handled next to engine or at rear of train.
4. The word "Car" means all cars or dead engines in a train. The tender of a locomotive is counted as a car.

19-B. A car having double equipment, i. e., two independent sets of air brakes, and one set cut out, or inoperative, will be considered as a non air car.

19-C. When brake pipe becomes defective on passenger, mail, express or milk cars enroute, signal pipe may be substituted for it by coupling signal hose at each end of car to brake pipe hose. Engineman must then be notified that one brake has been cut out.

19-D. The handling of a car with inoperative hand

brake is considered by the I. C. C., a violation of Safety Appliance Act. No car must be moved unless brake and staff are operative; except when crippled and in condition to be moved to the nearest repair point in direction in which the train is moving, but must never be the rear car in the train.

20. *Movement of Dead Engines in Trains:* Engines and tenders must have air brakes cut in and operative on drivers, trailer, engine and tender trucks.

20-A. Engines and tenders equipped with Westinghouse ET or New York LT brake must have safety valve on distributing valve or control valve, adjusted to not less than 25 or more than 30 pounds.

20-B. Engines and tenders equipped with automatic and straight air combined must have the safety valve in brake cylinder pipe adjusted to not less than 25 or more than 30 pounds.

20-C. Engines equipped with ET or LT brake must have positive stops applied to handles of automatic and independent valves to secure these handles in running position.

20-D. Engines and tenders equipped with high speed brakes without the straight air must have high speed reducing valves set to reduce the brake cylinder pressure to not less than 25 or more than 30 pounds, or must have a safety valve applied to brake cylinders or brake cylinder pipe set to not less than 25 or more than 30 pounds.

20-E. Engines fitted with power brakes other than air must be equipped with an air train line and connections.

20-F. Engines equipped with ET or LT brakes must have the cut-out cock of dead engine feature open.

20-G. The cut-out cock in brake pipe under the automatic brake valve must be closed.

20-H. Engines with ET brake equipment, and having no dead engine feature, main reservoirs may be charged as follows: Both brake valves secured in running position. Slack off all tension on feed valve regulating spring, plug the brake pipe exhaust. *In this case double-heading cock in brake pipe under brake valve must be left open.*

20-I. Air operated devices, with the exception of distributing or control valves, taking air from the main reservoir must have their operating valves securely closed.

20-J. Not more than four dead engines may be handled in one train. There shall be not less than five cars between the engine hauling train and the first dead engine and between any two of the dead engines.

20-K. A locomotive with power brake inoperative must not be moved light over any portion of the railroad. Such engines may be hauled to the shops in freight trains under steam, when this can be done without interrupting the train line or imparing the braking power of the train; otherwise they must be moved dead.

21. *Cutting Out An Air Brake:* Whenever it is necessary to cut-out the air brake on a car on account of its being defective, close the cut-out cock in crossover pipe and bleed the auxiliary reservoir. An air brake defect card Form 1029 must be filled out and attached to

the brake pipe near the triple valve, and must not be removed until the necessary repairs have been made.

TRAIN HANDLING

22. *Freight Trains:* The following method will be used in charging trains in which there is no pressure in the air brake system:

Charging Up: Lap the automatic brake valve sufficiently in advance to have maximum main reservoir pressure when coupling to the train. Trains should be charged with brake valve in full release position, and upon returning same to running position note the brake pipe pressure which should be within 5 pounds of the pressure carried, wait in running position for two minutes, then make a kick-off movement to full release position for 5 seconds, returning brake valve handle to running position.

23. *Starting:* Do not try to start until ample time has been allowed for brakes to release. See paragraph 28-D.

Freight trains should be started slowly, keep the engine at a very slow uniform speed for the first three car lengths and don't vary this even though a less distance would have started the entire train, also the speed for the first train length should not exceed 8 miles per hour, to enable the trainmen to watch for defects, stuck brakes or wheel sliding.

23-A. *Starting With Two Engines Ahead:* With two engines ahead, the second engineman should allow the head one to start the train, or if impossible, to almost

stall before aiding him. Starting together will cause a severe stress if any slack is in.

23-B. *Starting with a Helper on the Rear:* With a helper at the rear, its engineman should be the first to use steam in starting, always exercising the same care as just directed for the engineman with but one engine on a train especially so where the helper alone can start the train. The head engineman should be prepared to start promptly and carefully when the slack is pushed in to the head end, or when it is evident that the helper is stalled.

23-C. *Engine Slipping:* Excessive slipping of drivers causes severe shocks to draft rigging. The coupler springs cause the slack to change quickly, and this is usually followed by a severe shock with the renewed use of steam. Hence when slipping is probable, use sand and no more throttle than is necessary. The beginning of slipping will instantly reduce the steam pressure in the cylinders and with the quick and slight closing of the throttle then possible, will at once "Steady" the engine without much change of slack or loss of speed. With two or more engines in a train, excessive slipping of one will often cause the other or others to slip.

24. *Slacking:* In slacking to start a train, endeavor to take either a foot or two or the slack of the entire train, take but little if slacking the entire train will allow the rear end to run back, as an attempt to take all then will almost certainly cause damage. With a helper at the rear any slacking should be done carefully by the helper engineman, the head engineman should keep the

throttle open moderately, but prepared to temporarily ease off enough to prevent a lunge when it is started.

25. *The Independent or Straight Air Brake:* While freight train stops should generally be made with the train air brakes, yet where the speed, the weight of train, the grade, and the time available will permit of stopping with the locomotive brakes only without any liability of sliding drivers, overheating tires or producing rough slack action, such use is permissible.

25-A. *Using the Independent or Straight Air Brake to Bunch Slack and Stop Train:* The locomotive brakes may be used to bunch the slack in advance of an automatic application, or to alone make a stop, but a brake cylinder pressure of fifteen (15) pounds (graduated on in three steps) shall not be exceeded and said pressure shall not be held for more than one train length. If stop cannot be completed with the above pressure in distance required, train brakes shall be used to complete the stop.

25-B. *Graduating off; The Independent or Straight Air Brake:* When stops are made by the locomotive brakes alone they shall be graduated off, in such a manner before the train stops, as to allow the adjustment of draft gear springs and thereby prevent the resultant harsh running out of slack following the stop.

25-C. *Using the Independent or Straight Air Brake When Stopping Trains Ascending Moderate Grades:* When stopping a freight train with the locomotive brakes only, *when ascending any moderate grade,* reduce the holding power gradually as the speed gets lower, have it graduated off entirely and use steam lightly a few car

lengths before and until stopped. To do differently, may, cause the slack to run back after stopping, which is liable to damage draft rigging especially so if the locomotive brakes are then holding. If the train does start back, do not try to stop it quickly with the locomotive brakes, but make a light application of the train brakes.

25-D. *Do Not Use the Independent or Straight Air Brake Stopping Trains Ascending Heavy Grades:* With a freight train ascending other than a moderate grade, do not stop it with the engine brakes only.

25-E. *The Independent or Straight Air Brake Not to be Used Stopping Trains When Backing Up:* The locomotive brakes shall not be used to stop a train when making back-up movements, except in switching service when train brakes are not controlled by engineman.

25-F. *Don't Apply Straight Air Brake Until Slack Adjusts Itself:* In no case shall the locomotive brakes be applied independently before slack has had sufficient time to adjust itself after steam is shut off.

26. *Stopping with the Automatic Brake:* Service braking must be governed by the condition of rails, relation of brake power to the weight of the train, speed and grade, bearing in mind that safety is of the first importance. Always endeavor to maintain the auxiliary reservoir pressure as close to the maximum as possible for use in case of emergency, liable to occur at stations, as well as other points on the road. Attempt no "Spot Stops." This means, do not endeavor to run up close to a switch to head in. The main object is to stop properly within any reasonable distance short of the switch, the water or

coal chute. Proper stops cannot be made regularly, and at the same time, stop the engine at some desired spot. Trying to stop close to the switch, or to spot for coal or water, without cutting off with long trains causes trainmen more work, and train delay, by draft gear damage that occasionally results.

26-A. *When Stopping, Reduction To Make:* When stops are anticipated, shut off steam gradually and allow ample time for the engine to drift in the slack as much as it will before commencing to apply the brakes. At ordinary speeds make each stop with one application but with no less than two reductions. The amount of the first reduction should suit the speed and weight of the train and the steepness of the grade. It should not be less than five (5) to eight (8) pounds. For speeds of 15 miles per hour and less, use 5 to 7 pounds.

The object of using as light an initial reduction as practicable, is to keep the slack action down to a minimum. Therefore having made the first, reduction of 5 to 8 pounds, following reductions shall be made as desired, but the last reduction shall be made at a speed of six to eight miles per hour, or about forty (40) feet from the stopping point, and shall be such that air will be discharging at the brake pipe exhaust at the time the engine stops. The object of this final reduction is to start the slack in at a time too late for it to run out again before the stop is completed, thereby reducing strains on the draft rigging and bunching the slack more or less for starting. Good judgment must be exercised in making the final reduction at the right time, for if made too early

the application will have time to develop additional pressure in the rear brake cylinders, which is liable to cause a break-in-two rather than prevent one.

26-B. *Use of Sand in Stopping:* The continuous use of sand for the last eight or ten car-lengths will increase the holding power of the head brakes and will reduce liability of driving wheels sliding. Releasing the locomotive brakes or reducing their holding power at this time increases liability of damage to draft rigging and should be avoided if possible.

26-C. *Stopping Freight Trains While Using Light Throttle:* A method that may be followed in some instances, and used to good advantage, is where steam is being used approaching the stopping point is to continue its use until the first reduction of the brake application has brought the speed down, gradually shutting off the steam to prevent the engine from working harder as the speed becomes lower, then shutting off just before making the final reduction when within 40 feet from the stop, as directed in preceding paragraph 26-A. The purpose is the same, i. e., control of the slack, the continued and uniform use of steam tending to prevent the slack from running in at the beginning of the first reduction, hence, from running out again, as the tendency would be to keep it pulled out. This is similar to the use of steam when stopping while backing or ascending grades.

What method is best, will be governed more or less by local conditions, these being known to the engineman, he should employ the means that will, for the particular conditions, produce the best results.

Note: If the throttle is eased off or closed do not increase its opening upon beginning a brake application.

26-D. *Pusher Engine on the Rear:* Where helper engines are used on the rear of trains as pushers, the air hose must be coupled from the train to the engine on the rear, and brakes operated on pusher engine by the lead engine in control of the train. Engineman on pusher engine must close the cut out cock in brake pipe underneath brake valve where coupled to train, and when detached from the train, will open the cut out cock and make a service test of the engine brakes.

Engineman on pusher engines must use a light throttle when stops are being made, and continue to do so until the train is stopped.

26-E. *Illustrating Method of Stopping Ascending Grades:* The following will serve to illustrate the proper methods of stopping a freight train:

Suppose that on an ascending grade, the locomotive steam power had been gradually reduced by gradually closing the throttle opening, the train would reduce its speed gradually and the slack would remain stretched throughout the train. If it was necessary to apply the train brakes to prevent a backward movement of the train, a light application of the train brakes would then accomplish this without damage.

26-F. *Illustrating Method of Stopping on Level, Loaded Cars Ahead:* Assume a long train, having empties behind the loads, being stopped by the train brakes on a level grade and from a speed of 25 or 30 miles per hour; the first reduction should be from 5 to 8 pounds, and

brake pipe leakage which always exists more or less has reduced the speed to 6 or 8 miles per hour, the effect would be that the brakes on the empties would gradually pull on the slack and if no further reduction is made the slack would not change except to draw out more. Therefore, there could be no bad jerk, merely a hard pull, but even this would be avoided, if, when within about 40 feet of stopping, an additional reduction of 6 to 8 pounds were made, (as per paragraph 26-A) the forward brakes would then feel it first and would start the slack in, but the train would be stopped before the rear brakes could respond to this reduction and run the slack out again.

26-G. *Illustrating Method of Stopping on Level, Loaded Cars on Rear:* If the train were made up with empty cars on the head end and heavy loads on the rear, care should be taken that the initial reduction of brake pipe pressure is of sufficient amount and made at a distance which will insure the train stopping short of the desired point, for it is not desirable to make a further reduction of brake pipe pressure to complete the stop on account of the liability of damaging the equipment in the middle of the train, therefore, where the train is made up in this manner, guard against buckling it.

Note: Where possible, the loads should never be placed behind the empties.

26-H. *Heavy Initial Reductions at Low Speeds:* It is undesirable to make heavy initial brake pipe reductions at low speed, unless the stop can be completed before the exhaust at the brake valve ceases, the reason is mainly due to the high brake shoe friction at low

speed, and the more rapid application of the head brakes than those on the rear.

26-I. *Making Initial Reduction:* In making the initial service reduction of brake pipe pressure, always move the brake valve handle from running direct to service position, *never hesitate or loaf on lap position* before commencing same.

27. *Backing-up Movements:* When making back-up movements, stops should be made as follows:

27-A. *Backing-up with Locomotive on Head End:* With locomotive on the head end of train only, do not permit driver brakes to apply, keeping them off, by means of bleed cock or independent brake valve. Make a moderate service brake application of 6 or 8 pounds at the same time keeping the slack of the train bunched by working steam, using light throttle, until train stops.

27-B. *Backing-up with Helper Locomotive on the Rear:* In backing up a freight train with a helper locomotive on the rear end of train, make the stop as above directed. The helper engineman, will, however, assist in holding the slack by applying the independent or straight air brake. In all cases where such movements are made trainmen will set up caboose hand brake.

27-C. *Transferring the Handling from Head to Rear End When Making Back-up Movements:* When the utilization of air, or brake control from pusher engine is made necessary, this must not be resorted to except in an extreme necessity, when all concerned, including the two enginemen and conductor having a perfect understanding as to just what is to be done in order to prevent train damage or delay.

27-D. *Reversing the Engine:* An engine should not be reversed when the driver brake is set. With the latter properly maintained it offers far more efficient means of stopping than does the engine reversed.

28. *Releasing Brakes:* At how low a speed brakes can be released without liability of damage depends on how heavily they are applied, the amount of main reservoir pressure, the length of the train, whether the slack is in or out, also track conditions (sags, humps or curves). No rule can care for these varying conditions; enginemen must therefore exercise judgment.

Note.—Brake valve must not be placed in release running or holding position while air is discharging at brake pipe exhaust.

28-A. *Releasing Brakes at Low Speed:* Brakes must not be released on long freight trains when speed of trains is less than fifteen (15) miles per hour, except in grade work when retaining valves are used.

28-B. *Running Release of Train Brakes:* When making a running release the locomotive brakes must be held applied until train brakes are released, and then slowly graduated off; do not attempt to use steam until the train brakes are fully released.

28-C. *Release of Train Brakes After Stopping:* When trains have been stopped the brake pipe pressure shall have been reduced not less than ten (10) pounds, with sixty (60) cars or less, and not less than fifteen (15) pounds on trains of more than sixty (60) cars before attempting a release.

28-D. *Time Required to Release Train Brakes:* The

time required for the release of train brakes depends upon the length of the train, the main reservoir and brake pipe pressures at the time of release, brake pipe leakage and capacity of air compressor. Trains of less than 60 cars should not depart until at least two or three minutes after brake valve is first placed in full release position, longer trains four minutes.

28-E. *Releasing With Automatic Brake Valve:* After a service application, the proper way to release brakes on freight trains of from 35 to 100 cars is to use release position for fifteen (15) seconds, running (or holding) position for thirty (30) seconds, then make a three (3) second Kick-off to full release position and then return brake valve to running position. With "ET" equipment, make the first return from release to holding position, then after the Kick-off movement graduate off the locomotive brakes by movements from holding to running position. An exception to the above is made when releasing brakes from a ten (10) pound reduction on trains of less than forty (40) cars. In such cases the brake valve handle should be left in full release position about ten (10) seconds, instead of fifteen (15), as explained above.

When engines are equipped with the G-6 brake valve and straight air brake (A-1 Brake equipment) the straight air brake should be applied just before the automatic brake valve is moved to full release position. After making the Kick-off movement with the automatic brake valve, the locomotive brakes should be graduated off with the straight air brake valve. See 28-B.

28-F. *Time to Remain in Full Release, Following Cutting Off for Coal, Water and Switching:* To release promptly after making couplings, following cutting off for coal, water or switching, the main reservoir pressure should be high; insure this by lapping the automatic brake value sufficiently in advance to have maximum pressure when coupling is made. By use of the Independent or straight air brake on the locomotive, control the engine and cars if practicable while moving to make coupling. Brakes on cars that may be attached to the locomotive should be applied with a full service reduction before the angle cocks are opened, and held applied until cut in to rest of train. The brakes should then be released and recharged by moving the automatic brake valve to full release position (trains of 35 to 100 cars) for twenty (20) seconds, then to running position for thirty (30) seconds, this followed by a Kick-off movement to full release position for three (3) seconds.

28-G. *To Release When the Brake Pipe Is Empty:* To release when the brake pipe is empty, such as following burst air hose, break-in-twos, etc, with trains of 35 to 100 cars, the brake valve handle should be left in full release position for thirty (30) seconds instead of twenty (20) seconds as explained in 28-F.

Note carefully, that the foregoing refers only to releasing, and that it does not apply when recharging down grades, where to observe it would result in loss of pressure. For releasing and recharging on descending grades, see Instructions on *Grade Braking.*

28-H. *Do Not Release Brakes on Long Trains After*

Emergency: Do not release brakes on long freight trains after emergency action, no matter how high the speed may be. In case the brakes are applied from the train, lap the brake valve, shut-off, and ascertain the cause: A hose may have burst, the train may have parted, or the conductor's valve may have been opened.

28-I.—*Making the "Kick-Off" Movement with Brake Valve When Brakes Are Fully Charged:* Making the "kick-off" movement with the brake valve when the brakes are fully charged is undesirable, as it is liable to overcharge the head brakes and cause them to apply and stick. With proper releasing it is rare that any brake fails to release or finally re-apply.

28-J. *Locomotive Brake Creeps On:* The locomotive brake sometimes applies lightly, ("ET" equipment) or creeps on, with both brake valves in running position. The brake cylinder pressure developed may be sufficient to cause overheating and loosening of the driving wheel tires, without effecting the brake cylinder gauge, as a brake cylinder pressure of 2 pounds will force the piston out and bring the brake shoes against the wheels. Yet, no pressure would be shown by the brake cylinder gauge hand. The brake applies with both brake valves in running position, not because of any disorder in the distributing valve, but generally on account of an overcharge in pressure chamber, during a release of train brakes and the *failure* of the enginemen to properly make the *"kick-off"* movement with automatic brake valve. Again it may be brought about by a sluggish acting feed valve that does not open up promptly

and supply the brake pipe leaks. The unsupplied brake pipe will cause the equalizing portion of the distributing valve to move to service position and allow pressure chamber air to pass to the application cylinder, which will move the application portion and apply the brake.

The brake should be released by a quick movement of the automatic brake valve to full release and then to running position in order to force the equalizing portion of the distributing valve to release or normal position. To guard against the creeping on of engine brakes, while on the road the occasional moving of the independent valve to release will prevent overheating tires. But always release with the automatic brake value as above directed.

29. *Terminal Test of Passenger Trains:* As soon as the locomotive is coupled to the train and the required brake pipe pressure is equalized throughout the train, the engineman upon request or signal from a trainman or inspector shall make a 25 pound service application of the brakes, and hold them applied until the trainmen or inspectors shall have examined the brakes on each car.

If the trainman or inspector finds that the brakes have applied properly, he shall signal for the release of the brakes from the rear end of the train to the engineman (by communicating whistle signal), who shall release the brakes. A test of the brake is not complete until the trainmen or inspectors have examined the brake on each car, to know that they have released properly, after which they must report to the engineman the condition of the brakes.

30. *At Division Points or Division Terminals:* Where engines are changed or a change is made in make-up of trains. make tests as follows:

30-A. *Changing Engines and Testing:* After the incoming engineman has made the usual station stop, he will reduce the brake pipe pressure sufficiently to make a total reduction of 25 pounds. The inspectors will go over the train, and in addition to their other duties, they will note the piston travel. When the outgoing engine is attached, the engineman will release the brakes and upon signal from inspectors, or trainmen, will make the usual 25 pounds reduction of brake pipe pressure (it will not be necessary for outgoing engineman to wait until maximum pressure is obtained before making this test), and when inspector at rear of train sees the brake applied on the rear car, he will signal for the release of the brake by communicating whistle signal. If brakes release, it will indicate that no angle cock has been left closed in brake pipe.

In making the usual release following a terminal test, if all brakes fail to release properly, inspector or trainman will have the engineman repeat the test as may be required, instead of bleeding the auxiliary reservoirs.

The inspectors should be careful, however, to note that brakes are not being held applied by retaining valve in holding position, or hand brakes set.

31. *Smooth Handling:* Smooth handling of passenger trains requires that slack must never be changed suddenly. The action of the brakes in changing the slack will be most severe at low speeds. Therefore, avoid

any heavy reduction when speed is low. Similarly, starting quickly, slipping drivers, or taking slack harshly will cause shocks that are disagreeable to passengers and damaging to equipment. For this reason do not open throttle until brakes are released. Then open it gradually.

While time is an important factor in the maintenance of schedule, smoothness of operation should not be sacrificed for the small amount of time that can be saved in starting and stopping.

32. *Taking Slack of Passenger Trains:* When it is necessary to take the slack, close throttle, apply the independent or straight air brake; reverse the locomotive; and graduate off the independent brake. Use steam if necessary, to close in all train slack.

32-A. *Slack on Grades:* If, on an ascending grade or at a point where the train must be backed to a favorable place for starting, while working steam, make a brake pipe reduction of 6 to 8 pounds. Work steam moderately until stopped so as to have all slack closed in. Reverse the engine; start release of the brakes (before attempting a release make a total reduction of 15 pounds) and at the time when experience indicates that the brakes are releasing, say about 6 to 8 seconds, start to use steam but as carefully as consistent with starting the train and avoid damaging shocks.

33. *Service Stops, Passenger Trains:* To properly make service stops with the least liability of wheels sliding and to avoid disagreeable shocks, the two application method should be used when the train speed is above 40 miles per hour, as follows:

Steam should be gradually shut off early enough to allow the slack in the train to adjust itself before making the initial brake pipe reduction, which shall be 6 or 7 pounds to get the brakes applied and settle the slack in the train before heavy brake cylinder pressure is developed. Further reductions may follow as required. When the speed is reduced to 15 or 18 miles per hour, move brake valve handle to full release position long enough to start all triple valves to release (2 or 3 seconds for train of 6 to 12 cars), then return brake valve handle to service position until the equalizing piston responds (brake pipe exhaust opens), then to lap until the final application is desired. The second application should be a light one to ensure a smooth stop, and if train consists of 7 or more cars do not release the second application until after the train has stopped.

34. *Low Speed Stops:* When making stops at low speed, allow sufficient time between shutting off steam and starting the brake applications to permit the slack to adjust itself.

35. *Spot Stops:* When necessary to move a few feet, as for making a "spot stop," the brake application should be started as soon as the engine begins to move, instead of waiting until the stopping point is reached and then using the emergency position. The mistake is frequently made of waiting too long, before beginning the application, or not having the brake pipe and auxiliaries equalized after releasing before moving and making another application.

Note: When making stops at low speed or moving a passenger train for spot stops, as for coal or water, good results will follow where a light throttle is used while braking and to entirely close the throttle when stopped.

When switching at passenger stations, signals should be given in time for the engineman to properly control his speed when coupling on.

36. *Releasing With Seven or More Cars:* When making service stops with passenger trains of 7 or more cars, brakes must not be released after final application until train has stopped, while trains of less than 7 cars may have their brakes released just before stopping, providing the total brake pipe reduction is 10 pounds or over. If less than 10 pounds hold the brakes applied until stopped, then increase to 10 pounds before releasing. When *double heading* the same rules will apply, but under no circumstances must engineman on leading engine release brake on second application until train is stopped.

36-A. *Releasing Brakes—How Long to Remain in Release:* Release of train brakes must not be attempted until a reduction of 10 pounds or more has been made and the brake pipe discharge closes. Running position of the brake valve should not be used for releasing brakes, on the contrary, when it is desired to release, automatic brake valve handle should be placed in full release position, and at the proper time returned to running position, and then after waiting seven (7) seconds, make the "Kick-off" The time to stay in full release position depends on length of train, amount of brake pipe reduction made, and the

main reservoir pressure, however, the minimum length of time would be one second from one to five cars, two to three seconds, six to twelve cars, four to five seconds on long express or milk trains. But in no case long enough to raise the brake pipe pressure above the feed valve adjustment.

36-B. *Releasing Brakes After Emergency Application:* To release brakes after an emergency application, place automatic brake valve handle in release position and leave it there until brake pipe pressure is restored to the setting of the feed valve, then to running position.

36-C. *The "Kick-Off:* The "Kick-off" consists of moving the handle of the brake valve from running position to release for a second and then back to running position. When release position is used to release train brakes in passenger service, it should invariably be followed by the "Kick-off" about seven (7) seconds after returning to running position.

36-D. *Use of Sand, Passenger Service:* Do not use sand while braking on good rails, except in emergencies. Use sand to prevent wheel sliding on slippery rails, start it flowing before the brakes are applied for service application, and immediately after the brakes are applied for emergency applications, continuing its use to the stop.

37. *Emergency Stops:* In an emergency, where life or property is in danger, move the brake valve quickly to emergency position and leave it there until the train stops. As emergency application produces maximum braking force, it may cause shocks and slid flat wheels; hence, may be used only to avoid injury to persons and damage to property.

38. *Slow Downs, Passenger Train Service:* While still working sufficient steam to keep the slack well out of the train, make a brake pipe reduction of about 7 pounds. After the exhaust closes, follow by further reductions as required to obtain the desired low speed. To insure a prompt and certain release of all brakes the reduction must total 10 pounds before attempting to release. If less, add the needed amount just before releasing, but do not release before the service exhaust ceases.

Note: Conductors must notify enginemen when the train is not handled smoothly.

39. *Brakes Sticking, Passenger Trains:* One cause for brakes sticking is failure to release, due to attempting to release a lighter application than is authorized.

39-A. *Stuck From Reapplying, Failure to "Kick-off":* Another cause is brakes reapplying on the locomotive or the head end of the train after releasing, and a failure to make the "Kick-off."

39-B. *How to Release Stuck Brakes:* If stuck brakes are noted on a running train that is fully charged, the best way to release is to make a reduction of 10 pounds, wait until the service exhaust ceases, then make the regular release, followed by the "Kick-off."

40. *Backing Train Movements, Passenger Trains:* When backing train, such as through cross-overs, out of side tracks, etc., operate the locomotive and train brakes as directed in *Paragraph* 27-A.

41. *Back-up Hose:* The back-up hose provides for the application of brakes from the rear end of a train.

Opening its valve suddenly, as should be done only in case of an emergency, will cause quick action. For a service application the valve should be opened slowly, yet fast enough to drive the brake pistons out, and the opening should be gradually increased until the desired holding power is obtained.

Maintaining the discharge will keep the brakes applied, and stopping it will result in the brakes releasing and recharging, owing to the handle of the engineers' brake valve being in running position.

41-A. *Testing Back-up Hose Before Backing Up:* Before backing train when back-up hose is used, a brake test must be made by making an application from the back-up hose, and the engineman will signal to the trainman when the air gauge indicates a reduction of brake pipe pressure has been made.

41-B. *Position of Engineers' Brake Valve and Use In Backing Up:* When making such backing movement, engineman will carry the automatic brake valve in running position. The only exceptions is that the engineman will apply the automatic brake whenever necessary to ensure the safety of the train, and will release the brakes in the usual manner, as soon as any stop is completed.

41-C. *Backing Long Freight Trains:* When backing long freight trains, in transfer or other service, all ordinary braking must be done from the locomotive in control. With such trains do not use the back-up valve except to avoid danger and then with all care that the conditions will permit, as its use is liable to cause severe draft gear and lading damage.

42. *Brakes Applied From Unknown Cause:* Should the brakes apply from an unknown cause, it indicates that a conductors' valve has been opened, a hose has burst, or other serious brake pipe leak has occurred, or the train has parted. In such a case close the throttle immediately, lap the automatic brake valve, and leave it on lap until the train has stopped, and the signal to release has been given. The engineman should be advised of the cause before proceeding. The engineman must assist the trainmen in avoiding delay in locating burst hose, or other similar cause, by admitting enough air back through the brake pipe at intervals to help locate the defect.

43. *Detaching Locomotive From Train, or Air Brake Becomes Inoperative on Grades:* If a locomotive is detached from a train, or the air brake becomes inoperative, trainmen will be governed as follows:

43-A. *On Ascending Grades:* On ascending grades promptly apply the hand brake on each car, beginning with the rear car in the train, and if necessary block the wheels.

43-B. *On Descending Grades:* On descending grades, train must be secured in the same manner, commencing the hand brake operation on the first car in the train.

43-C. *Brake Test Before Starting:* Before starting and before releasing hand brakes and removing any blocking from the wheels that was necessary, wait a sufficient time for all auxiliary reservoirs to fully recharge. A test of the air brakes must then be made before starting.

44. *Double Heading:* With more than one loco-

motive, control the train brakes from the head locomotive and have air signal (if engine is so equipped) connected to and operative on it. The cut-out cock underneath the brake valve in the brake pipe on other locomotives must be closed, and air compressors kept working.

44-A. *When Coupling Helper On:* When a train is to have a helper locomotive coupled on ahead, the regular engineman will apply the train brakes with a 25 pound brake pipe reduction before the helper couples on, and close the double heading cock under automatic brake valve. The helper engineman will, after coupling, release the brakes and make brake test, as per *Paragraph* 16.

44-B. *When Helper is Cut Off:* When a helper locomotive ahead is to be cut off, its engineman will apply the brakes with a 25 pound reduction. The regular engineman, then in charge, will release them and make the brake test as per *Paragraph* 16.

44-C. *Do Not Cut in Brake on Any But Head Locomotive Except for Emergency:* The automatic brake valve on other than the head locomotive, must not be cut in at any time, or for any reason except for a plainly needed emergency application, of which the head engineman is unaware or unable to make.

44-D. *If Conditions Require Change of Brake Control:* If any condition arises in either passenger or freight service that necessitates change of brake control, stop, have a full understanding, change control, and insure by a brake test that the other engineman has full control before proceeding. Change the locomotive from which the brakes are controlled to the head at the first

siding if the brake pipe of the defective locomotive can be used.

44-E. *Starting Trains When Double Heading:* In starting the train with two locomotives ahead, commencing to use steam at the same time will cause severe shocks and damage, therefore, the second engineman must not use steam until the head engineman has started the entire train, or has done all he can to this end. Follow the same order where use of steam is required while running. Braking with two locomotives ahead must be done with more than the usual care, to avoid rough handling, this because of the additional weight and slack at the head end, and, usually the extra length of train.

44-F. *Making Switching Movement with Two Locomotives:* When two or more locomotives are coupled and making a switching movement to or from the train, the leading locomotive, which is to be in charge of the train on the road, shall operate the air brakes on both when making such movements. When two or more locomotives are coupled, moving light over the road, the air brake will be operated from the leading locomotive in the direction they are moving.

GRADE BRAKING

45. *Grade Braking, Safety in Grade Work:* Safety in grade work, insofar as braking is concerned means recognition of the fact that the "down hill push" of the grade, which increases with its steepness and the load, is always acting to start a locomotive or train, and to increase its speed when running: That this offsets part of

the braking power, all of which would be effective in stopping the train on a level track. That speed is very important, higher speed both decreasing the brake shoe friction or holding power and increasing the brake work to stop. Twenty (20) miles per hour compared with ten (10) miles per hour requires about four times the brake work to stop the train, at thirty (30) as compared with ten (10) miles per hour, the work would be nine times as great.

45-A. *Safety and Speed Beginning Descent:* Although standing brake tests with knowledge of results, as to number of cars in the train, the number of good brakes, etc., are necessary before starting, yet the ability to control or stop a train as indicated by this must be for the sake of safety, confirmed by the first few applications after passing the summit. Speed should be kept low until this is determined, and later governed accordingly.

46. *Brake Test at Summit:* Before descending heavy grades, and as covered by time table, rules and general instructions, freight trains must be stopped by air brakes, and when the stop is made, the trainmen will examine the brakes to see that they are applied throughout the train; brakes will then be released from the engine, after which retainers must be turned up where rules require, and air pressure fully restored before the train is started. Brake pipe pressure and main reservoir pressures must be maintained as per paragraph 5.

47. *Use of Retaining Valves on Loaded Trains:* If the train consists of loaded cars all retaining valves must be turned up before commencing the descent, and so remain

until train has descended the grade, unless it is found that some of the wheels are becoming overheated, when retaining valves on those cars must be turned down. If the retaining valves when they are all up, cause too much braking power, turn enough of them down to let the train proceed safely under the control of the engineman.

47-A. *Use of Retaining Valve on Mixed Loads and Empties:* If the train consists of loads and empties, it is advisable to turn up those on all loads and every second or third on empty cars.

47-B. *Use of Retaining Valves on Other than Grade Specified in Timetable:* On grades other than those covered by timetable, rules or general instructions, enginemen will advise trainmen the number of retaining valves to be used to safely control the train.

47-C. *Turning Down Retainers:* In turning down retaining valves to allow train to start, or at foot of grade, trainmen should commence turning them down from the rear working towards the head end.

48. *Speed on Descending Grades:* Trains should begin the descent of a heavy grade at low speed and the air brakes should be applied as soon as the train begins to accelerate; this to determine the effectiveness of the brake, and also the holding power of the pressure retaining valves when a release is made.

48-A. *Keeping Speed Low for First Mile of Descent:* Keep the speed below 15 miles per hour for the first mile of descending grade to determine if the air brake force is ample to safely control the train.

48-B. *Brake Efficiency on Grades:* The efficiency of

the brake as indicated by the first few applications after beginning the descent, and while speed is yet low, must be the factor in determining whether the maximum allowable speed for that grade shall be attempted with that train. If the brakes do not seem to be amply efficient the speed must be kept low, remembering that a train moving at 10 miles per hour is about 4 times harder to hold than when moving 5 miles per hour, and only one-fourth as hard to hold at 10 as if moving 20 miles per hour.

49. *Safe Pressure Descending Grades:* If at any time while on the grade the engineman finds the brake reserve insufficient—as will be indicated by necessity for making more than a 15 pound brake pipe reduction, or inability to fully recharge before a train begins to accelerate materially—he shall immediately call for hand brakes and apply the air brake fully for the purpose of bringing the train to a full stop.

49-A. *Stopping Account, Insufficient Air Pressure and Insuring Safe Movement:* After a train which is stopped on account of insufficient air brake reserve to safely control it is fully recharged, and it is understood between enginemen and trainmen that the latter will use a sufficient number of hand brakes to insure safe control, the train will proceed. Hand brakes should be alternated to prevent excessive wheel temperatures.

50. *Method of Braking on Grades:* No fixed rule can be made to cover the amount of reduction that should be made during each brake application, as different trains hold differently; but the engineman can determine by the

result of the first few applications about how much brake power will be required to produce these desired results. Speaking generally, the brakes should be applied each time the auxiliaries are recharged and the "one reduction" method must be used. This is done by making a sufficiently heavy brake pipe reduction to prevent the speed from increasing or reduce it the required amount. When releasing brakes and recharging auxiliary reservoirs the brake valve handle must be left in full release position until the brake pipe pressure is fully restored, before returning it to running position. To avoid overcharging the head brakes, it is necessary in handling freight trains, if time permits, after the brakes have been released and brake pipe pressure entirely restored, to move handle to running position for 7 to 10 seconds, then make the "kick-off" movement before commencing the next application.

51. *Short Cycle Method of Grade Braking:* After passing the summit and before the train speed exceeds 15 miles per hour make a brake pipe reduction of 8 to 10 pounds, and as soon as the brake pipe discharge ceases, and the train commences to slow down, the brake valve handle should be moved to full release position and brake pipe pressure restored. As soon as the train starts to gain in speed, make one reduction as before, and when the exhaust ceases at the brake valve and train starts to slow down, release and recharge. This method should be followed until the foot of the grade is reached.

With the short cycle method the brakes will be found to be more responsive and the train control more flexible

than the old method of long holds. This is because the frequent applications tends to make each brake do its share, while the frequent releases keeps the auxiliaries charged as near the maximum pressure as possible, thus insuring greater train safety.

52. *Driver Brakes on Grades:* Under no circumstances should the driver brake be used continuously down long heavy grades to an extent at all likely to overheat and loosen tires. It may be used occasionally at the most difficult places to assist in holding the train while recharging or when descending grades with light engines.

53. *Stop on Grades:* Where a stop is made on a heavy descending grade, apply the independent or straight air brake (handle of independent or straight air brake valve to be in application position), release and recharge the train brakes and if stop be of lengthy duration, trainmen should immediately apply hand brakes to secure the train.

54. *Detaching Locomotive from Train on Grades:* If for any reason locomotive is to be detached from the train a sufficient number of hand brakes must be set up to insure the train being held, before the locomotive is cut-off. See 43-A and 43-B.

54-A. *Don't Release Hand Brakes Until Engineer Whistles Off Brakes, or Until Full Pressure is Obtained:* Under no circumstances should hand brakes be released until the engineman whistles "Off Brakes." A train must not be allowed to start from the summit, nor following any stop while descending the grade, until charged to the pressure prescribed for the grade.

55. *Train Parting on Descending Grade:* When descending heavy grades, if the train should become separated by accident or otherwise, the angle cocks on each portion of the train where separation occurs must be closed and that portion of train not attached to the locomotive secured with hand brakes, commencing at car at the lowest portion of grade.

55-A. *Train Parting on Ascending Grade:* On heavy ascending grades, trainmen must watch carefully to prevent, by prompt application of hand brakes, detached portion from starting backwards in case the train parts.

56. *Setting Out Cars; on Grades:* In setting out cars on grades, see that the air brakes are entirely released by bleeding the auxiliary reservoir pressure, before applying the hand brakes fully when the cars are detached. Otherwise the cars may start when the air leaks off. Applying the hand brake with the air brakes set may result in a broken hand brake chain when the air leaks off. If not, it will render the hand brake hard to let off. Block the wheels if necessary.

57. *Wheels Overheating or Sliding on Grades:* While trains are in motion on descending grades, trainmen must watch out for signs of wheels overheating or sliding, as liability of wheel sliding is greatest on starting, and particularly so after a heavy application when retaining valves are in use. Hence, the train should be held until at least three minutes after the train brakes are released so that retaining valves may blow down; even then, on starting, trainmen should inspect from the ground for wheel sliding, and enginemen should keep speed low

enough for trainmen to get on safely. A stopped-up retaining valve vent port is liable to cause wheel sliding or excessive heating. Where excessive holding power indicates this fault, observe whether the valve blows strongly at this port when brakes are being recharged. If not, and the port cannot be opened with a pin, cut out that retaining valve (handle down) if necessary to prevent excessive heating or wheel sliding.

58. *Hand Brakes:* While descending grades trainmen should not apply hand brakes on any car having air brakes operative, unless called for by the engineman, except to hold trains during stops, when sufficient hand brakes to hold the train must be applied as soon as the stop is completed, and the circumstances require it.

59. *Locomotive Air Gauges:* The engineman should frequently observe the air gauge to guard against the pressure becoming too high, or too low. He should also observe the air gauge during the brake operation to note the effect of the brakes with different brake pipe reductions, and also the amount and effect of brake pipe leakage, as well as the amount and rate of rise in brake pipe presure while releasing brakes.

When *one* gauge is used on a locomotive, the black hand indicates equalizing reservoir pressure and brake pipe pressure at all times, except during a service application, and the red hand main reservoir pressure.

When *two* gauges are used, the black hand on the larger one indicates equalizing reservoir pressure, the red hand main reservoir pressure. The black hand on the other or smaller gauge indicates brakes pipe pressure, and the red hand brake cylinder pressure.

With the brake valve handle in release position, the two hands on the larger gauge should correspond, as well as the black hand on the small gauge. If a difference of over three pounds is noted, report the gauges for test.

59-A. *Caboose Air Gauges.* As all cabooses are equipped with air gauges, conductors and trainmen are required to use this device as an additional precaution against danger from low air pressure which may be due to a closed angle cock, or an obstruction in the brake pipe.

Note particularly whether it indicates ample air pressure at times when such may be needed, and take prompt steps to locate the cause and render assistance, where it does not. This is particularly important when descending grades.

Where the grade requires the frequent use of the air brakes to control the speed, following a stop, the train must not be allowed to proceed until full pressure is restored. This implies using hand brakes if necessary to hold the train while recharging. Also in case of a heavy reduction in brake pipe pressure without a corresponding decrease in speed, at once aid with hand brakes without waiting for same to be called for.

If it is observed that with different locomotives, the caboose gauge varies over 5 pounds from the pressure that is shown on the locomotive gauge when engine is attached to caboose, report the gauge to be tested.

60. *Pressure Retaining Valve:* This valve is located on the end of the car near the hand brake wheel. It must be used on grades where it is necessary to hold the brakes

applied while recharging the auxiliary reservoirs, and to hold the slack of the train when operating conditions require. It is connected by a small pipe to the triple valve exhaust port and through it the air is exhausted from the brake cylinders when the brakes are released. When the handle is pointing downward the port is fully open; when up or horizontal (crosswise the pipe) a certain portion of the air is retained in the brake cylinder after the triple valve is in release position. Some cars are equipped with the three position retaining valve, in which the third position, midway between horizontal and vertical, known as the 45 degree position, retains a higher pressure in the brake cylinder than the horizontal (crosswise) position. *See questions and answers for different types of retainers.*

60-A. *Responsibility of Conductor on Use of Retaining Valves:* On trains descending heavy grades as specified in time table rules, the conductor will be held responsible for knowing that the handles of the pressure retaining valves are in the proper position.

60-B. *Trainmen's Duties on Use of Retaining Valves:* Trainmen will set these valves for use when necessary, and must change them back to vertical or normal position as soon as their use is no longer required. Neglect in this will cause the brakes to drag, and may cause damage to wheels.

61. *Conductor's Valve, Its Use and Purpose in Emergencies:* The conductor's valve is merely a valve of suitable design for applying the brakes from inside the car or a caboose, and has the same effect as opening the rear

angle cock. It is therefore nothing more than an emergency device and should not be used under any other circumstances. There are two kinds of emergencies that warrant its use, one is immediate danger to life or property that is noted first by a trainman. In such the conductor's valve should be pulled wide open as quickly as possible and kept so until the train has stopped, then closed.

61-A. *Conductor's Valve, Its Use at Other Times:* The other is where it is imperative that the train shall be stopped in any reasonable distance, but not as quickly as possible. As where an excessively hot box is noted while running and a signal to stop cannot be got to the engineman. Under this or any similar condition, the conductor's valve should be used with great care, opening it very gradually and steadily, so as to avoid causing the brakes to apply in quick action; when it is felt that the brakes are slowing the train at a sufficiently rapid rate, the valve opening should be maintained until the train is stopped, then closed.

As a leaky conductor's valve is a brake pipe leak, this defect should be reported and repaired promptly.

61-B. *Conductor's Valve, Testing:* While the brakes are applied during terminal tests, the conductor's valve in caboose should be tested by opening it sufficiently to prove that it or the pipe is not obstructed.

The conductor's valve in each passenger equipment car should be tested at the principal terminals where trains are made up, also the signal car discharge valves as well.

62. *Undesired Quick Action:* Undesired quick ac-

tion can be caused with freight trains, especially long ones, by a very light brake pipe reduction of 3 or 4 pounds, or a very slow reduction such as lapping the brake valve and allowing brakes to leak on, where it would be avoided by braking properly.

62-A. *Testing for Undesired Quick Action:* Where undesired quick action occurs with proper braking, proceed to locate it at the first opportunity. The hardest ones to locate is where it does not "dynamite" at standing applications, only when making a stop.

Before starting to test to locate the faulty valve, have observers distributed along the train, standing back about two car lengths from it so that by hearing, and seeing in daylight, they may be able to note the direction from which the quick action comes and thereby be able to confine attention on the portion of the train where it starts.

When testing, enginemen should have train brakes fully charged at least five or six minutes before making a reduction of brake pipe pressure, then make a slow reduction of 3 or 4 pounds, wait on lap a full half minute, then if the faulty triple has not "dynamited" add a further reduction of 6 or 7 pounds.

After quick action occurs and before a release signal is given to the engineman, the observer who thinks he has located it, should cut out the brake he believes at fault, also cut out two brakes on each side of it. After the engineman releases the brake, he should *slowly* open each of the cut-out cocks he has closed until the brake starts to release, then move the cut-out handle about on-

fourth of an inch farther towards open position. The object in doing this is to make a large enough opening through the cock for the brake to charge and to respond to a service reduction, yet so small that if one of them applies quick action it cannot reduce the brake pipe pressure fast enough beyond the cock to throw the other brakes into quick action. A further advantage *while standing* of the five brakes *almost* cut out is that, even if the faulty valve is not among them, they will usually stop quick action and thereby show in what direction further attention should be given. If, however, the faulty valve is among these five *almost* cut out, it alone will apply quick action and will usually release immediately.

When the "dynamiter" is located that brake should be cut out and carded. Then all other brakes that were *almost* cut out, must be fully cut in. (See questions and answers for method of testing for undesired quick action from the rear end.) A brake test must then be made before proceeding.

63. *Air Brake Defect Card:* Form 1029 will be supplied to conductors upon order. These cards properly filled out are of great value in the maintenance of air brakes. Report all brake defects existing on cars in trains, a separate card for each car, and in every case furnish all information called for by the card. Attach same to brake pipe near the triple valve.

64. *Long Brake Pipe and Brake Pipe Leakage:* The effects of the resistance to the air flow in the brake pipe and of large volume (more brakes in use) are not observed with two or three cars but with a few more cars

the effects becomes noticeable and are very much pronounced in long trains. The longer the train the greater will be the time between the application of the brake nearest the locomotive and that farthest from it. Similarly, when air flowing into the brake pipe for releasing, the time between the triple valve moving to release position on the car next to the locomotive and that on the car farthest away will be greater the longer the train. These differences in time between the head brake and the rear ones applying and releasing cause slack action. Also the rate of recharging will be slower on the car farthest away from the locomotive. Failure to appreciate these facts and to brake accordingly will cause damage to draft rigging and lading, as well as delay and unsatisfactory operation.

64-A. *Cause for Brakes Sticking on Long Trains:* The engineman who has rear brakes stick on a long train because of endeavoring to release after a light reduction from standard pressure, is failing to appreciate the effect of pipe friction and the volume to be filled; that to get the best rise at the rear end of a long train without charging the head brakes above standard pressure requires a heavier reduction before attempting to release.

64-B. *Differential in Pressure on Head and Rear End of Long Trains:* Another effect of long brake pipe is that the pressure at the rear end will be lower than at the engine when fully charged. If leakage is kept low, this difference will be small with the longest trains, but will increase with the leakage that must be supplied through the brake pipe. Also, any certain leak near the rear end

will cause more difference in pressure between the two ends than where the same leak is near the engine.

64-C. *Differential in Pressure on Head and Rear End Due to Leakage:* While with long trains and accurate air gauges, that a few pounds less pressure is to be expected at the rear or caboose than at the engine, yet where this difference is more than usual for the length of train it shows that there is excessive leakage that should be located and repaired.

64-D. *Effect on Air Compressor Due to Leakage:* As brake pipe leakage increases the time required to charge and to recharge a train, makes more work for the air compressor, renders it harder to release brake, lessens the enginemen's control of the amount of each brake application, prevents keeping the rear end of a long train fully charged and wastes air (meaning fuel) it is therefore plain that such leakage should be kept low.

64-E. *Time Wasted:* No time should be wasted in discussing pump capacity or where the leakage may be; the trainmen, or inspectors and engineman should get together and prove whether abnormal leakage exists, on the locomotive, or the train and correct it.

64-F. *Engineman's Test for Brake Pipe Leakage:* A test that will give the engineman early information is to note the loss on the brake pipe gauge hand in the first minute after the brake pipe exhaust closes off, following, the brake pipe reduction made for the terminal brake test. Where there is any question as to the leakage being excessive on the road, make the following test:

With brakes fully charged to 70 pounds, make a re-

duction of 10 pounds, and commencing as soon as the brake pipe discharge ceases (at 60 pounds) note the loss in pressure in one minute.

64-G. *Rate of Leakage, 30 and 60 Cars:* Brake pipe leakage under the above test should not be over 6 pounds at the most. It should be borne in mind that the actual amount of air lost for any given rate of leakage is in proportion to the length of the train. For example, a leakage of 60 pounds per minute requires twice as much of air to supply it with 60 cars as the same rate of leakage does with 30 cars. Again for example, the brake pipe volume of a 36 foot car is about 640 cu. in., the volume of 10—36 foot cars would be 6400 cu. in.—while the engine would also have about 640 cu. in. of brake pipe volume. Now, if a leakage test showed 5 pounds per minute for the engine and cars, and the cars were all tight, with all the leakage on the engine, a test of the engine alone would show leakage at the rate of about 50 pounds in one minute, or 10 times that shown by the engine and cars together, because the engine's brake pipe volume is only one-tenth that of the whole train of 10 cars. Therefore, if a train and engine showed 5 pounds per minute, and the engine alone showed 5 pounds per minute leakage, it does not mean that the engine has all the leakage, but that every car in the train is leaking at that rate, or else, somewhere in the train there is a leak heavy enough to compensate and make the leakage average 5 pounds per minute for the engine and train. Likewise, if the engine was leaking 10 pounds per minute and was coupled onto 10 cars that were tight, by in-

creasing the brake pipe volume 10 times the visible rate of leakage would be decreased to one-tenth of the original, or to one (1) pound per minute.

65. *Brakes Sticking on Freight Trains:* As a rule the cause of brakes sticking is due to the failure to raise the brake pipe pressure quickly above the auxiliary reservoir pressure, which must be done in order to move the triple valve parts to release position.

It is more difficult to release the brakes on a long than a short train, and there is a difference between triple valves that stick and fail to release, and those that release with the others and reapply, or those that creep on when the brakes are not being used. The first mentioned may be due to failure to raise the brake pipe pressure promptly, or an individual triple valve having a bad packing ring; the second mentioned and which is most likely to occur on the head end is due to an overcharge; while the third mentioned, i. e., the creeper can be caused by an erratic working feed valve, a closed angle cock, or the engineman moving the brake valve handle to release and back to running position after the train is charged: Therefore if the experience of every day practice is made use of and good judgment exercised much of the trouble can be anticipated and prevented.

If a brake is found sticking on a car, first see if the retainer is not turned up, hand brake set, or the brake rigging fouling at some point, also look for very short piston travel.

If any particular triple valve shows a tendency to stick frequently and the others release promptly, cut it out,

block the auxiliary bleeder open and attach an air brake defect card *Form 1029* marked "brake sticks."

66. *Incoming Terminal Brake Test:* The incoming terminal brake test is to find defects in season to permit of making the needed light repairs in the yard and of marking cars requiring heavy repairs for the repair tracks, all before the switching is done, so that outgoing trains when made up can be got out of the terminal in good order with the least possible delay. ff this test is made as directed and the brake defects located by it and a general inspection are cared for properly, there will rarely be any repairs required, during the outgoing test other than to stop brake pipe leaks.

Enginemen and trainmen of freight trains on arrival at terminals will leave the brakes applied for inspection.

66-A. *Engineman's and Trainmens' Duties Regarding Incoming Brake Test:* Upon arrival and on stopping the train where it is to remain, the engineman should at once add to whatever brake pipe reduction was required to stop enough to make a total of 20 pounds. The brakeman should not close the angle cocks to cut engine from the train until the engineman signals with one short blast of the steam whistle that the application is completed.

66-B. *Inspection and Repairs, Incoming Brake Test:* Inspectors will at once examine for piston travel, brakes failing to apply and that have leaked off and brake pipe-leaks. At this time make no repairs; merely indicate the defect with chalk. After completing the inspection, repair the defects that should be cared for in the yard, such

as adjusting piston travel (less than 6 or over 8 inches) to 7 inches; loose or broken pipes; cotters and brake pins missing; other brake rigging defects; retaining valves loose, broken or missing hand brake defects; cylinders and reservoirs loose; angle cocks and hose out of proper position. Consider cars over 12 months since brakes were cleaned as having defective brakes; loads that cannot be held for brake repairs, will, where destination is a terminal, be marked on arrival "B. O. when empty," and delivered to repair tracks as soon as unloaded.

66-C. *Inspectors Watching Out for Flat Wheels on Inbound Trains:* Where practicable, inspectors will so station themselves that incoming trains will pull by them so as to observe and make note of any pounding wheels, such to be examined during the general inspection to determine what repairs are necessary.

67. *Yard Test:* A yard test requires a thorough test of the air brake and signal apparatus, with repairs to all parts needing it on cars in yard or repair track and must be made as soon as possible after train arrives. *See Paragraph* 66.

67-A. *Passenger Yards:* At passenger yards and originating terminals a thorough inspection must be made of brake beams, hangers, pins, cotter keys and all parts of the foundation brake gear and apparatus, and brakes tested in accordance with instructions. Brake shoes must not be applied without first letting out the automatic slack adjuster.

67-B. *Inspectors Must Change Defective Triple Valves:* Inspectors will make no repairs to triple valves.

The valve must be replaced by one in good order and the defective one sent to such repair point as may be specified.

67-C. *Inspectors Must Tighten Loose Pipe Clamps and Turn Angle Cocks to Position:* Inspectors must not let an opportunity pass to tighten loose pipe clamps, or replace missing ones, stop leaks, turn hose or angle cocks to proper positions, tighten bolts holding cylinder and reservoir to car body, replace defective coupling gaskets and adjust piston travel.

67-D. *Inspectors Must Have Convenient, Necessary Air Brake Parts to Make Repairs:* Inspectors must have on hand, in a convenient place, all necessary parts in good condition for making prompt repairs to the air brake and signal equipment. They will be held strictly responsible for the condition of all brakes and signal equipment upon cars placed in trains at their stations. They must also make an examination of the air brake and any necessary repairs to same, which they may be called upon to do by the trainmen. Whenever making any adjustments of rods or levers under cars, the cut-out cock in crossover pipe must first be closed and auxiliary reservoir bled to protect person doing the work from injury.

67-E. *Dummy Couplings, Angle Cocks and Hose Gaskets:* Dummy couplings on passenger equipment must be seen to be in proper condition, angle cocks tight on the end of the brake pipe, and standing in proper position. In replacing hose gaskets no cutting or trimming will be permitted. If the groove in coupling is clean and

coupling not defective, the gasket is at fault and must not be used.

67-F. *Retaining Valve Pipe Disconnected:* If retaining valve pipe is disconnected, it must not be coupled unless brake is charged with air, so that it can be tested at once. It may have been disconnected on account of having been stopped up. Also see that it is properly clamped.

67-G. *Special Attention to Air and Hand Brake on Repair Track:* Special attention must be given to air and hand brakes on cars on repair tracks, and it is required that no car leave this track with defective brake or with improper piston travel. All air hose must be tested under pressure, using soap suds when weather condition permits, and same must be replaced when found porous or defective.

67-H. *Car Inspectors at Junction Points:* Car inspectors at junctions must see that the air brake apparatus is in good working order when cars are received from other railways.

68. *Air Brakes on Freight Cars:* Cars on shop and repair tracks (with stencils in date) must be connected to a yard air plant equipped with testing apparatus and a dummy coupling attached to hose on the opposite end of car. The pipe, including angle cocks, cut-out cock and hose, to be tested under a pressure of not less than 70 pounds, using soapsuds for this test when weather conditions permit. All possible leakage should be eliminated. Any hose found porous or leaking around the fittings, or

otherwise defective, and any cocks found leaking at top of key should be removed. See that the brake pipe is securely clamped, angle cocks in their proper position, reservoirs and cylinders tight on their supports and the latter securely attached to car, and that piston travel is adjusted to 7 inches.

68-A. *Shop and Repair Track Tests:* The brake cylinder must be tested for leakage as follows: Where the retaining valve has its exhaust port tapped out, the test gauge must be attached. If retaining valve is not tapped for the purpose, then attach the gauge to the triple valve exhaust port, the triple valve then tested by applying and releasing the brake with the specified test device. Now note brake cylinder leakage which should not exceed 12 pounds in one minute from an initial pressure of 50 pounds in the brake cylinder and with a brake piston travel of six or seven inches. If the brake cylinder leakage is greater than 12 pounds, the entire brake equipment must be given the attention specified for cars requiring annual cleaning and repairs. If the brake passes the above test, the retaining valve must be tested. Apply the brake; turn up retaining valve handle; then release; in three minutes turn the handle down and note the discharge of air which should be fairly strong. If, however, there is no discharge when handle is turned down, another test must be made, when triple valve goes to release, quickly apply soapsuds to all joints and the retainer. Repair any defects found and retest, until pipe is tight.

69. *Annual Air Brake Cleaning and Repairs:* The air brake equipment on freight cars shall receive the fol-

lowing inspection and repairs at least once in 12 months, or if stencil date is nine months old or over and car is on shop or repair tracks where the work can be done.

70. *Cleaning, Lubricating and Inspecting Brake Cylinders:* First, secure the piston rod firmly to the non-pressure cylinder head, then, after removing the non-pressure head, piston rod, piston head and release spring, scrape off all deposits of gum and dirt, and thoroughly clean the removed parts.

70-A. Oil must not be used for cleaning cylinder piston packing leathers, as it destroys the filler; this however, does not apply to WABCO Cups.

70-B. Thoroughly clean the brake cylinder, including non-pressure head joint, by using a dull rounded scraper for removal of the heavy grease and dirt, wiping dry with rags or waste. Use no oil unless the substance in the cylinder cannot be removed without softening. Rust spots inside of cylinder are to be removed with fine emery cloth.

70-C. Particular attention to be paid to cleaning the leakage groove and the auxiliary tube. Triple valve must be removed when the auxiliary tube is being cleaned.

70-D. Expander ring, when used, should be a true circle when applied to the packing and fit the entire circumference, having an opening of from 3/16-inch to ¼-inch. When removed from the cylinder, the ring openings should be 1½-inch, to 1 9/16-inch and with this opening will not be a true circle. It is preferable to exchange defective expanders for others of similar type that have been tested and made to conform to cylinder.

Expander rings are not to be used with "WABCO" Cylinder piston packing cups.

70-E. A packing which is badly worn should be replaced with a new one. If a leather packing is slightly worn on one side, but otherwise in good condition, it should be turned so as to bring the worn side away from the bottom of the cylinder. The packing must be placed centrally on the piston head with the flesh side of leather packing next to cylinder.

70-F. Follower studs to be firmly screwed into the piston heads, and nuts on same to be drawn up uniformly tight before replacing piston.

70-G. The inside of the cylinder and cylinder piston packing should be lightly coated, with the prescribed brake cylinder lubricant.

70-H. No sharp tools should be used in entering the piston packing into the cylinder.

70-I. After a piston, on which a leather is used, is entered in the cylinder, and before cylinder head is replaced, the piston rod should be slightly rotated in all directions, about 3 inches from the center, to be certain that the expander ring is not out of place.

70-J. All stencil marks to be scraped off and painted over with a quick drying black paint. The place of cleaning, the initials of road, day, month and year to be stenciled with white paint on one side of the auxiliary reservoir, as shown on standard drawing, or if same is not readily visible, in a convenient location near the handle of release rod on the reservoir side of the car.

70-K. The bolts, nuts and lock-nuts holding the cylinder and reservoir to their supports, and the latter to the car, to be securely tightened, using washers between bolting flanges and supports where necessary to avoid strain in brake cylinder when supporting bolts are tightened.

70-L. After cleaning the brake cylinder it must be tested with a gauge attached to the exhaust port of the triple valve before connecting the retainer pipe. Where the latest type of retainers are used, the gauge must be connected to the exhaust port of the retaining valve. In either case, the gauge will indicate cylinder leakage on releasing the triple valve after an application and when attached to the retaining valve it will also test the retainer and retaining valve pipe.

70-M. Brake cylinder leakage must not exceed 5 pounds per minute, from an initial pressure of 50 pounds, with piston travel adjusted to 7 inches.

70-N. Each time the triple valve and the brake cylinder is cleaned, the brake pipe, brake pipe strainer and branch pipe must be thoroughly blown out and the triple valve strainer cleaned before recoupling the branch pipe to the triple valve. If a dirt collector is used, the plug must be removed, the accumulation blown out and the threaded portion of the plug coated with oil and graphite before replacing.

70-O. All union gaskets must be made of leather especially treated for the purpose. The use of rubber in unions is not permitted.

70-P. Piston travel should be adjusted to 7 inches.

70-Q. When brake cylinders and triple valves are

cleaned, the following additional work should be performed. Retaining valve cleaned by removing the cap, wiping or blowing out all dirt and seeing that the valve and its seat are in good condition, the retaining position exhaust port open and the valve well secured to the car in a vertical position; pipe clamps applied where missing, and tightened where loose, hose and angle cocks turned to their proper position. Pipe joints, hose, release valve, angle and cut-out cocks must be tested under a pressure of not less than 70 pounds, using soapsuds for this test when weather conditions permit. The retaining valve and its pipe must be tested and the leakage from the cylinder, retaining valve and retaining valve pipe must not be greater than 5 pounds in one minute from a brake cylinder pressure of 50 pounds.

70-R. Inspect for wornout, defective or missing brake shoes, brake beams, loose brake heads, also the foundation brake gear and observe that the rods and levers are of proper dimensions and stand at the correct angles. Remove all brake beam hangers that are bent, cracked or worn beyond a safe limit. Also see that brake connection pins and cotters are not missing, and that pins are not unnecessarily installed upside down.

The hand brake must also be examined to see that it is effective.

71. *Changing Triple Valves at Cleaning Time:* The triple valves must be removed from the car and replaced by one known to be in good condition and has passed the prescribed tests on the Triple Valve Test Rack.

71-A. When replacing triple valves, apply the gasket

to the triple valve, first, with the ribbed side of the gasket next to the triple valve.

72. *Train Air Signal:* In order to be of value as a means of communication between cars and locomotives in passenger train service, it is necessary that the operative parts be kept in good condition both on the cars and locomotives.

72-A. The locomotive signal equipment must be tested properly before departure each trip from engine-house. The signal line on cars and locomotives must be kept tight.

72-B. The signal apparatus operates similar to the air brake, in that it requires a reduction of signal line pressure to cause a blast of the whistle and, therefore, time must be allowed between reductions at the car discharge valve, for the pressure in the signal line to recharge and equalize.

72-C. When necessary to transmit signals from car to the locomotive cab, the best results will be obtained by a direct downward pull on the valve cord. In order that proper blasts of the signal whistle are obtained, an exhaust of not less than one (1) second duration, with not less than three (3) seconds intervening between pulls on the cord. With a train of ten (10) cars or over, allow at least four (4) seconds between discharges.

72-D. A defective car discharge valve can be cut out of service by closing the cut-out in signal branch pipe near the discharge valve.

72-E. If the whistle fails to operate from any particular car it should be noted whether the blast from that

car discharge valve is weak, and if so it indicates that there is insufficient lift of the discharge valve from its seat, or else a partially choked air strainer in the branch pipe leading to the car discharge valve. Trainmen will report such conditions to inspectors upon arrival at terminals, in order that repairs can be made.

72-F. When the train air signal for some cause becomes inoperative at any time, conductor or trainmen must notify the enginemen, who will be governed by hand, flag or lamp signal.

73. *Broken Pipes on Locomotives and Cars:* When it becomes necessary to make repairs to any part of the air brake equipment back of the main reservoir cut-out cock, and before closing same, on engines having "ET" equipment, place the handle of the automatic brake valve in release position and close the double-heading cock.

74. *Single Top Governor:* If the copper air pipe to the governor breaks, stop the leak, and control the air compressor by the steam throttle, guarding against too high main reservoir pressure.

75. *Double Top Governor:* If the air pipe between the main reservoir and the high pressure top of governor should break, stop the leak, and control the compressor with the steam throttle as with the single top governor. If the pipe to the low pressure top should break, simply stop the leak, as then the other top will control the compressor when maximum pressure is reached.

76. *G-6 and H-6, Brake Valve, Pipes Breaking to Air Gauge:* If either copper pipe to the air gauge should break, stop the leak.

77. *G-6 and H-6, Brake Valve, Pipe Breaking to the Equalizing Reservoir:* If the pipe to the equalizing reservoir should break, stop the leak and if possible to do so, plug the brake pipe exhaust fitting, and brake carefully from the emergency position. If, however, you cannot plug the exhaust fitting, use the service position in the usual way for making the brake pipe reduction, and when the desired reduction has been made, carefully close the double-heading cock. When handle is in service position, further reductions can be made by opening the double-heading cock beneath the brake valve as conditions require. To release place brake valve in release position, then open double-heading cock, and release train brakes as usual.

78. *Feed Valve Pipe Broken; "ET" Equipment":* A broken feed valve pipe between the main reservoir connection, and the brake valve connection prevents air from being supplied to the brake pipe in running and holding positions and makes it necessary to carry the brake valve in full release position; therefore, plug the opening toward the brake valve, slack off on the feed valve adjusting nut until there is no tension on the spring, then adjust the pump governor to the brake pipe pressure being carried, also slack off the union nut on the short copper pipe between the two brake valves.

79. *Application Cylinder Pipe:* If the application cylinder pipe breaks, plug the opening from the distributing valve and proceed; the automatic brake can be operated as usual, but the brake cannot be operated with the independent valve on account of the broken pipe.

80. *Main Reservoir Supply Pipe to Distributing Valve Breaks:* If main reservoir supply pipe to distributing valve breaks, the locomotive brakes will be inoperative, unless repairs can be made, as this break cuts off the supply of air from the main reservoir to the distributing valve. It may be possible to repair the break, by connecting two signal hose up, i.e., screw one into distributing valve after removing the broken piece of pipe, and the other hose to the supply pipe cut-out cock. If no signal hose are at hand, use the two brake cylinder hose between tender and the locomotive.

81. *Distributing Valve Release Pipe:* If the distributing valve release pipe breaks, it need not cause any delay, as it only cuts out the holding feature of the automatic brake valve, and only effects the slow application and lap position of the independent brake valve.

82. *Driver Brake and Tender Brake Cylinder Pipe:* Driver brake, and tender brake cylinder pipes, are equipped with cut-out cocks with "ET" equipment. Should the pipe break between these cocks and the respective brake cylinders, close the cock. Should a break occur between the distributing valve and cylinder cut-out cocks, close the main reservoir supply pipe cock: the locomotive will then be without a brake.

83. *Branch Pipe Broken:* If brake pipe branch pipe is broken, stop the leak on the side towards the brake pipe, operate the locomotive brake with the independent valve, and the train brakes as usual.

84. *Dead Engine Feature:* If dead engine feature pipe breaks, stop leak and proceed.

85. *Broken Brake Pipe on Tender:* If the brake pipe under the tender breaks, or the angle cock is broken off, and tender is equipped with a signal line, connect brake pipe hose on rear of engine with signal line hose on front of tender. Then connect signal line hose on rear of tender with the brake pipe hose on the first car. If, when metallic joints are used, between engine and tender, plug the broken pipe toward the engine and connect brake pipe and signal hose on pilot.

86. *Straight Air Brake Pipe:* If the supply pipe breaks between the straight air brake valve and the reducing valve, slack off all tension on the reducing valve regulating spring. If the supply pipe breaks, between the reducing valve and the main reservoir, plug the pipe towards the main reservoir.

87. *Signal Line Pipe:* If the supply pipe to the signal reducing valve breaks, plug towards the main reservoir. If the signal pipe on engine or tender breaks, close cut-out cock at signal reducing valve.

88. *Broken Pipe on Passenger Cars:* If the brake pipe on a passenger car breaks, couple the signal hose to the brake hose on adjacent cars, and close cut-out cock at car discharge valve. On car with broken brake pipe open all reservoir drain cocks.

88-A. *Broken Pipe on Last Car:* When brake pipe is broken at head end of the last car in the train, plug broken pipe and connect brake hose with the signal hose on the rear end, also connect brake pipe hose on next car ahead with signal hose on rear car, close cut-out cock in

signal line near car discharge valve. Arrange to have the necessary repairs made at the first opportunity.

89. *Slack Adjuster Pipe:* If a slack adjuster pipe breaks, plug the end towards the brake cylinder.

90. *Supplementary Reservoir Pipe L-N or P-S Brake:* If supplementary reservoir pipe breaks, on cars equipped with the L-N or the P-S brake, plug the opening toward the triple valve, unless the break is beyond cut-out cock when same can be closed.

91. *P-C Equipment:* Should the emergency reservoir pipe break, plug pipe toward the control valve. If the service reservoir pipe breaks, close the cut-out cock in the branch pipe, and leave all reservoir drain cocks open.

92. *U-C Equipment:* Should the auxiliary reservoir or the service reservoir pipes break, close the cut-out cock in the branch pipe, and leave all reservoir drain cocks open.

92-A. Should the pipe leading to the emergency reservoir break, plug toward the universal valve. If the brake cylinder pipe should break, close the cut-out cock in brake cylinder pipe.

93. *Freight Car Brakes:* Should the cross-over, or branch pipe break, between the triple valve and the cut-out cock, close the cock and bleed the auxiliary reservoir, block the bleed cock open.

94. *Water Raising System Private and Sleeping Cars:* Should the pipe break between the reservoir and cut-out cock, plug the pipe toward the reservoir. If pipe breaks between cut-out cock and water raising system, close cut-out cock.

95. *Exchanging Feed Valve and Reducing Valve Enroute:* If a feed valve becomes so defective enroute as to prevent safe and satisfactory braking, the engineman, may with train standing and secured with hand brakes, close the double-heading and main reservoir cut-out cocks and exchange the feed valve and independent brake reducing valve, and readjust the reducing valve for the standard brake pipe pressure. Then make the required brake test and proceed.

ESSENTIAL PARTS OF THE AIR BRAKE AND TRAIN AIR SIGNAL

An air brake is a brake with which compressed air, instead of hand power is used to cause the brake shoe pressure.

1. The steam driven air compressor, which produces the pressure for operating the brakes, and train air signal.

2. The compressor governor which controls the main reservoir pressure, by decreasing or closing off the steam supply to the compressor to prevent the accumulation of more than the pre-determined main reservoir pressure.

3. The main reservoir which receives and stores the air compressed by the compressor. The main reservoir acts as a cooling chamber for the compressed air, and as a catch basin for moisture and oil which is precipitated from the compressed air by cooling. It also acts as a storage for other air-using devices without interfering with brake pipe pressure, and to serve as a backing volume or driving head of excess pressure for the purpose or releasing train brakes and recharging the system.

4. The engineers' automatic brake valve, which controls the exhaust of air from the brake pipe for applying the brakes, and the flow of air from the main reservoir into the brake pipe for releasing the brakes.

5. The brake pipe, including the branch pipe, hose and couplings, which connects the engineers' brake valve, and conductors' valve with the triple valve on each car; angle and cut-out cocks are provided in the brake pipe on each car, the former for opening or closing the brake pipe at any desired point in the train, and the latter to cut-out or in the individual triple valve.

6. The triple valve, to which the brake pipe, the auxiliary reservoir, the brake cylinder and pressure retaining valve are connected, it controls the flow of air to charge the auxiliary reservoir, to apply and release the brakes.

7. The auxiliary reservoir, in which the compressed air is stored for applying the brake on its individual car.

8. The brake cylinder provided with a cup packed piston, and piston rod, connected with the brake levers in a manner, that when air pressure enters the cylinder the piston moves and applies the brake.

9. The pressure retaining valve, when cut in for service on heavy descending grades, retards the discharge of air from the brake cylinder down to a pre-determined amount, and then retains that amount, when triple valve parts are in release.

10. A double pointer air gauge on the locomotive, indicating main reservoir and brake pipe pressure.

11. The conductors' valve, located in all passenger equipment cars and in cabooses, for applying the brakes from the train when an emergency arises.

12. The high speed reducing valve, or safety valve, for reducing the pressure in the brake cylinder when it exceeds a pre-determined amount in service applications.

13. The train air signal reducing valve, which reduces main reservoir pressure to signal line pressure.

14. The train air signal line, including strainers, stop-cocks, cut-out cocks, hose and couplings.

15. The car discharge valve from which the signal pipe pressure is reduced to transmit signals.

16. The signal valve and the signal whistle.

GENERAL INFORMATION FOR THE MAINTENANCE OF AIR BRAKES, AIR SIGNAL AND TRAIN HANDLING

The safe control of trains is dependent on the efficiency of maintenance and manipulation of the air brakes. Those who make use of the apparatus must have a knowledge thereof to the extent herein given, which is also a guide to further investigation.

1. Q. What power is used to operate the brakes on locomotives and trains?
   A. Compressed air.
2. Q. How is the air compressed?
   A. By an air compressor on the locomotive.
3. Q. How does the compressed air apply the brakes?
   A. It is admitted into a brake cylinder on each car, and it pushes out a piston in that cylinder, which through levers, rods, etc., pulls the brake on.
4. Q. What two systems are in use?
   A. Straight air and automatic.
5. Q. Where is the automatic used?
   A. On locomotives, tenders and cars.
6. Q. Where is the straight air brake used?
   A. On locomotives, tenders and motor cars.

STRAIGHT AIR BRAKE

7. Q. What equipment is necessary on locomotives, tenders and motors cars for operating straight air brake?

A. A compressor, main reservoir, reducing valve, straight air brake valve, safety valve, and on locomotives and tenders a double check valve.

8. Q. With the straight air brake, where is the air stored?
   A. In the main reservoir.
9. Q. How is the brake operated?
   A. By admitting air to the brake cylinders, direct from the main reservoir.
10. Q. What is the straight air brake valve used for?
    A. To apply and release the brakes on locomotives and tenders independent of the automatic brake.
11. Q. What is the straight air reducing valve used for?
    A. To reduce the main reservoir pressure to the proper pressure for the brake cylinders.
12. Q. What is the straight air brake safety valve used for?
    A. To limit brake cylinder pressure.
13. Q. What prevents air escaping from the triple valve exhaust when the straight air brake is applied?
    A. The double check valve.
14. Q. If with straight air brake applied you heard a strong blow from exhaust port of triple valve, where would you look for the cause?
    A. Double check valve leaking.
15. Q. What prevents air escaping from the straight air brake valve exhaust when automatic brake is applied?
    A. The double check valve.

16. Q. What pipe connections lead to ends of double check valve?

A. The pipe from the triple valve, and the pipe from the straight air brake valve.

17. Q. What pipe connections lead to sides of double check valve?

A. The brake cylinder and safety valve.

18. Q. When taking coal or water, when working around the engine, oiling, etc., or, when it is left standing alone, in what position should the handle of the independent or straight air brake valve be left?

A. When leaving engine while doing work about it, oiling, etc., the handle of the independent or straight air brake valve must always be left in the application position.

19. Q. If with straight air brake applied, and brake valve handle of straight air brake in application position, you heard a strong blow at safety valve, what would cause it?

A. Either reducing valve is set for too high pressure, or dirty, allowing pressure to run up above 45 pounds. Safety valve may also, be adjusted too low.

20. Q. If straight air brake applied as above and you find air compressor continues to work, not stopping or slowing down, what would this indicate?

A. Leaky packing cups, in the brake cylinders,

pressure head gasket leaking or blown out; or pipe leading to brake cylinders leaking.

21. Q. When straight air brake is used on road locomotives, what is its purpose?

A. For bunching the slack, keeping it together while releasing train brakes, or controlling slack of train any time, also when switching, and in handling locomotives light.

TYPES OF AUTOMATIC BRAKES ON LOCOMOTIVES

22. Q. How many types of automatic brakes are used on locomotives and tenders?

A. Two. The old type of automatic known as the type A-1 equipment and the improved automatic control system, i.e., the "ET" equipment.

23. Q. What equipment is necessary on locomotives and tenders to operate old type A-1 automatic brake?

A. Air compressor, main reservoir, engineer's automatic brake valve, brake pipe, plain triple valves, auxiliary reservoirs and brake cylinders.

24. Q. Where is the compressed air kept ready for use with the automatic air brake?

A. In the main reservoir on the locomotive, in the smaller or auxiliary reservoirs and in the brake pipe.

25. Q. Where does the air come from directly that enters the brake cylinder when the old style automatic brake is applied?
A. From the auxiliary reservoir.

26. Q. How does it get into the auxiliary reservoir?
A. Through the triple valve from the brake pipe, when brakes are released.

27. Q. Where is the brake pipe supplied from?
A. From main reservoir through the engineer's brake valve.

28. Q. How does the new automatic "ET" equipment differ from the old automatic?
A. A distributing valve and reservoir is substituted for the triple valve and auxiliary reservoirs.

AIR COMPRESSORS

29. Q. How many different types of air compressors have we in service on this road?
A. Four. The 9½-inch, and the 11-inch Westinghouse single stage compressors. The 8½-inch cross compound Westinghouse compressor and the New York number five duplex compressor.

30. Q. Name the working parts of the steam end of the 11-inch compressor? Also the 8½-inch cross compound compressor.
A. Differential piston valve, moves a slide valve; this slide valve admits and exhausts the steam to and from the steam cylinder. Reversing

valve which admits and exhausts steam to and from the chamber to the right of the large differential piston. The reversing valve rod operates the reversing valve. The reversing valve rod is operated by the reversing plate which is attached to the main steam piston. With the 8½-inch compressor, the steam valve admits steam to the high pressure steam cylinders; exhausts steam to the low pressure steam cylinder and then to the atmosphere. The reversing valve admits and exhausts steam to and from the chamber to the right of the large piston. The reversing valve rod operates reversing valve. The reversing valve rod like the 11-inch compressor is operated by the reversing plate on the main steam piston.

31. Q. Name the working parts in the steam end of the New York duplex compressor?

A. Piston valves attached to valve rods which admits and exhausts steam to and from the steam cylinders, the piston valves are operated by the reversing valve plates attached to the steam pistons.

32. Q. How should an air compressor be started, and run?

A. In starting a compressor, always run it slowly until it becomes warm, permitting the condensed steam to escape through the drain cocks and the exhaust, until there is sufficient

pressure in the main reservoir (40 to 50 lbs.) to provide an air cushion. Then close drain cocks and open the steam (throttle) valve sufficiently to run the compressor at the normal speed. Never run the compressor faster than it is necessary to do the work required. Racing or running at excessive speeds is not permitted. The compressor governor automatically controls the starting and stopping of the compressor.

33. Q. Why should the piston rod on the air compressor be properly packed?
    A. To prevent leakage of air and steam.
34. Q. If a 9½ or 11-inch air compressor stops, what should be done?
    A. *First:* See that lubricator is feeding oil to the steam end.
    Second: Shut off the steam throttle for a short time and open it again.
    Third: Tap the top head lightly with steam turned off, then turn same on quickly.
35. Q. If compressor now fails to start what should be done to locate the trouble?
    A. Open drain cock in steam passage to ascertain if the governor or throttle allows steam to reach the compressor.
36. Q. If the drain cock test proves the trouble to be in the compressor, how should the examination be conducted?

A. Remove the plug in the lower air cylinder head and examine if the piston rod nuts are in place and tight, or if rod is broken.

37. Q. If after examining air end, it is found to be all right, where should you next look for trouble?

A. Before again inserting plug in bottom of air cylinder head, would secure a long bolt and push the piston up about half way in cylinder, remove the reversing valve chamber cap and lift the reversing valve rod to determine if it is broken, if the reversing plate is loose, or a loose steam piston.

38. Q. If plate and rod are intact what next should be done?

A. Replace cap, turn steam on, if the piston makes the up stroke and stops it is probably due to a reversing plate stud working out or head breaking off, possibly main piston valve head is stuck in its cylinder.

39. Q. What other defects will stop the compressor?

A. The rings on the larger differential piston leaking so bad that the pressure cannot be unbalanced, the passage from the outer end of the small piston stopped up, or nuts coming off large differential piston.

40. Q. What effect will a bent reversing valve rod have?

A. It will have the effect of "half stroking" piston.

41. Q. What will cause the pounding in the steam end?
A. Main steam piston loose on its rod, one reversing plate stud loose, worn reversing plate or reversing rod.

42. Q. What will cause pounding in the air end?
A. A loose air piston, nuts loose on rod, loss of cushion from receiving valve, piston rings leaking, discharge valves having too much lift and pounding on their seat, pump not properly secured to bracket on boiler, or the bracket loose on the studs.

43. Q. If an 8½-inch cross-compound air compressor stops what should be done?
A. Proceed the same as with a 9½-inch or 11-inch.

44. Q. If an 8½-inch cross-compound compressor is running fairly well but pounds badly, what is the trouble?
A. See answer to single stage compressor.

45. Q. When a cross-compound compressor is first applied to a locomotive it runs properly, but later develops slow operation, what might be the trouble?
A. This may be due to lack of lubrication, air passages stopped up, leakage around air valves or cages, air cylinder piston rings badly worn, especially high pressure air piston rings, a cut or worn reversing valve or its seat, main valve piston rings leaking.

46. Q. What will cause compressor to make irregular strokes?

A. A leaky or stuck air valve, one having too much lift, or a stopped up passage will have the same effect.

47. Q. What will cause compressor to run slow with steam throttle fully open?

A. Discharge passages restricted with gum usually caused by excessive lubrication or inferior oil, defective steam head gasket, or a defective governor.

48. Q. What will cause a compressor to groan?

A. This is usually caused by improper lubrication, air or steam piston rings sharp, or fitting too tight.

49. Q. How much oil should be given to the steam cylinders?

A. From two to three drops per minute, depending upon the type of compressor, whether one or two, also the kind of service.

50. Q. How much oil should be given the air cylinders?

A. About one-half cupful each 50 or 60 miles, depending upon the service, and this to be a good grade of valve oil.

51. Q. If an 8½-inch "CC" compressor, high pressure steam piston is making irregular strokes, what may be the trouble?

A. Ascertain if the suction on both top and bottom inlet strainers is the same. If it is, it is due to steam piston valve trouble. If the suction is irregular it is due to an air valve not operating properly.

52. Q. If the low pressure steam piston is making irregular strokes on an 8½-inch "CC" compressor, what is usually the trouble?

A. Discharge valves on high pressure air cylinder are not operating properly.

53. Q. If an 8½-inch "CC" compressor is making regular strokes, but runs slow, what is often the trouble?

A. Low steam pressure, but if steam pressure is high, then trouble is often due to ports of passages being stopped up in the air cylinders due to using too much cylinder oil.

54. Q. How much higher must the steam pressure be than the air pressure for the 8½-inch, 150-cross-compound compressor to operate properly?

A. Where the main reservoir pressure carried is 120 pounds, the steam pressure should be 160 pounds, or at least 40 pounds above the air pressure.

55. Q. If an 8½-inch "CC" compressor runs fairly well, but after the governor has stopped compressor, it does not start promptly, what is the usual cause?

A. A sluggish acting governor.

56. Q. What are some of the other causes?

A. Not enough oil in steam end; steam throttle not open enough to permit sufficient flow of steam; or discharge valves leaking.

57. Q. If a New York compressor stops, what should be done?

A. Endeavor to start the same as a Westinghouse.

58. Q. If the compressor then does not start, what further can be done to locate the trouble?

A. Shut off the steam, take out the oil cups on top of the air cylinders and push both pistons to the lower end of their strokes, turn on the steam.

59. Q. If the right or low pressure piston travels up and stops, and left piston remains down, where would the defect be located?

A. Broken valve steam on right or low pressure side.

60. Q. If both pistons go up and stay?

A. Probably broken valve stem on left or high pressure side.

61. Q. Which steam valve operates right or low pressure piston?

A. The left one

62. Q. Which steam valve operates the left or high pressure piston?

A. The right one.

63. Q. If the right piston travels up very slowly but returns fast, what is the trouble?

A. Upper intermediate air passage choked, or valve is stuck to its seat.

64. Q. If the left or high pressure piston travels up very slowly, but returns fast, what is the trouble?

A. Upper discharge valve is broken or passage choked.

65. Q. If right or low pressure piston goes up normally, but returns quickly, what is the trouble?

A. Upper intermediate valve unseated, or copper gasket blown out between the two cylinders.

66. Q. What will cause a New York compressor to short stroke?

A. This may be due to air valves sticking open, particularly the intermediate discharge valve, also piston valve rings worn until ring tension will not hold valve in position, the latter will also cause compressor to stop for short periods and then start to work again, sometimes complete stoppage. When a New York compressor stops occasionally during the run, report main valve rings for examination, upon arrival at terminal.

67. Q. When a locomotive is equipped with two compressors, should both of them be operated?

A. Yes, as long as both are in good order.

68. Q. When necessary, to cut out a defective compressor on a locomotive which has two, how should it be done?

A. Close the valve in branch steam pipe, open drain cocks on steam cylinders.

69. Q. What will cause a New York air compressor to run slow?

A. This may be due to worn rings in main steam valve, defective (copper) steam head gasket, or gasket between center piece and steam cylinders, a defective governor may be the fault, the passages in same restricted by oil or gum, or the steam supply pipe partially closed with carbonized oil.

70. Q. If a compressor should stop before the required pressure is had in the main reservoir, possibly when 40 or 50 pounds is obtained, where would you look for the trouble?

A. If it should stop before the pre-determined pressure is reached, the trouble may be due to a leaky diaphragm valve and vent port stopped up, in the governor.

71. Q. If a cross-compound compressor will not maintain more than 50 or 60 pounds, and the governor being in good condition, where would the trouble be?

A. This would be caused by serious leakage past the intermediate or final discharge valves, and will also cause irregular strokes. Broken high pressure air piston flanges, or worn rings will have the same effect.

GOVERNOR

72. Q. What is the duty of the compressor governor, usually termed the pump governor?

A. The governor controls the flow of steam to the compressor.

73. Q. What air pressure operates the governor?
A. Main reservoir pressure.

74. Q. Name the working parts of the governor?
A. The regulating spring, diaphragm and stem, the diaphragm (pin valve) valve and its spring, the governor piston and the steam valve.

75. Q. Trace the air through the governor and explain how the steam is shut off?
A. Air from the main reservoir flows under the diaphragm, and when the pressure exceeds the tension of the regulating spring, the diaphragm will be raised, carrying the pin valve up with it, opening the port in the seat, allowing main reservoir air to flow down on top of the governor piston forcing it down and closing the steam valve. When the pressure in the diaphragm chamber becomes less than the regulating spring tension the diaphragm is forced down seating the pin valve; the air on top of the governor piston escapes through the vent port and governor piston resumes normal position and steam flows again to the compressor.

76. Q. What are the duties of the waste port, also the vent port in the governor?
A. The duty of the waste port is to allow any steam that leaks past the steam valve, or any

air that leaks past the governor piston, to escape to the atmosphere.

The duty of the vent port is to allow the air on top of the governor piston to escape to the atmosphere, when the pin valve closes.

77. Q. If a governor will not stop the compressor, where is the trouble?

A. If no air is escaping from the vent port in neck of governor, the passage from the pressure head to the governor piston, or possibly the air pipe to the governor, is stopped up. If air is escaping from the vent port the piston is stuck in open position, see if small air pipe to governor is split or broken off, an enlarged vent port will have the same effect.

78. Q. If a governor will not allow the compressor to run, where is the trouble?

A. If air is escaping at the vent port, the diaphragm or pin valve leaks, or dirt on its seat which holds the piston down and steam valve closed. If no air is escaping from the vent port, the piston is likely to be stuck in closed position.

79. Q. If governor stops the compressor at the proper time, but it does not start promptly when the main reservoir pressure is reduced, where is the trouble?

A. Usually due to the vent port stopped up, or a badly worn steam valve stem or guide.

80. Q. If the vent port is open and a considerable variation of pressure is required to stop and start the compressor, where is the trouble?
A. The diaphragm is probably cracked, or the pin valve is of improper length.

81. Q. If the copper air pipe leading to governor should break off from vibration or accident, what should you do?
A. If a single governor, plug the opening to stop waste of air, use steam throttle to prevent too high pressure being accumulated; if duplex S. D. type and the pipe to excess or low pressure top, would stop flow of air, the maximum pressure top would then control pump.

82. Q. To adjust feed valves with G-6 and H-6 brake valves, where should the brake valve handle be placed?
A. In running position.

83. Q. To adjust low pressure top of duplex governor, where should the brake valve handle be placed?
A. In running position.

84. Q. To adjust the high pressure top, where should the brake valve handle be placed?
A. Lap position.

85. Q. To adjust governor does it matter where the brake valve handle is placed when locomotive is equipped with single governor?
A. No.

BRAKE VALVES

86. Q. How many types of automatic brake valves are there in use on this road?

A. Two. The Westinghouse type G-6, and the H-6 with "ET" equipment.

87. Q. How many types of independent brake valves are there in use on this road?

A. Three. With the "ET" equipment, the Westinghouse S-6 independent brake valve, with the old type A-1 brake, the S-3 straight air brake valve, also the New York plate 22 straight air brake valve.

88. Q. What controls the main reservoir and the brake pipe pressure with the G-6 brake valve?

A. A compressor governor connected to the main reservoir controls this pressure. Brake pipe pressure is controlled by a feed valve when the brake valve is in running position.

89. Q. What controls the main reservoir pressure with H-6 brake valve?

A. When brake valve is in full release, running and holding positions the low pressure governor top. When the brake valve handle is in lap, service or emergency position, by the pressure top connected to the main reservoir, known as a maximum pressure head.

90. Q. What controls the brake pipe pressure with the G-6 automatic brake valve?

A. The feed valve.

91. Q. What controls the brake pipe pressure with the H-6 brake valve?

A. Brake pipe pressure is controlled by feed valve in holding and running position.

92. Q. Name the positions of the handle of the different types of automatic brake valves?

A. The G-6 has five positions; release, running, lap, service and emergency.

The H-6 has one more position between running and lap, called holding position.

93. Q. Name the valves in the automatic brake valve?

A. The rotary valve, and the equalizing discharge valve.

94. Q. What are the duties of these valves?

A. To allow air to flow to the brake pipe to release the brake and charge up the system; to discharge air from the brake pipe to apply the brakes; to prevent the flow of air to or from the brake pipe when holding the brakes applied.

95. Q. For what purpose is the small reservoir connected to the volume of air above the equalizing piston?

A. To increase the volume in chamber D.

96. Q. What is the purpose of the choke opening located in the tee connection at the brake valve from the equalizing reservoir pipe?

A. This is to retard the flow of air from chamber D to the equalizing reservoir while releasing brakes to hold the equalizing piston down and discharge valve on its seat.

97. Q. In making a service application of the brake, where does the first discharge of air escape from and through what port?

A. From chamber D through the preliminary exhaust port to the atmosphere.

98. Q. How may the preliminary exhaust be tested?

A. By placing the automatic brake valve handle in service position, and note the time required to reduce the equalizing reservoir pressure 20 pounds, i.e., 70 to 50 should require 9 to 11 seconds—from 110 to 90 pounds, 5½ to 7 seconds.

99. Q. What causes the automatic operation of the equalizing piston in the automatic brake valve?

A. The pressure reduced from chamber D and equalizing reservoir causes less pressure on top of equalizing piston than the brake pipe pressure beneath it which will cause it to raise, and exhaust an equal amount or slightly more pressure from the brake pipe to the atmosphere, than was reduced from the chamber D, whereupon the equalizing piston seats.

100. Q. What function has full release position—H-6 valve?

A. To release brakes, charge the brake pipe quickly

and hold the locomotive and tender brakes applied while the train brakes are being released.

101. Q. How is the holding feature accomplished?
A. A small copper pipe connects the exhaust from the application chamber with a port in the automatic brake valve. This port is opened to the atmosphere in the running position only. Hence locomotive and tender brakes will be held on in all other positions.

102. Q. What function has running position?
A. To supply the brake pipe through the feed valve and release the locomotive and tender brake.

103. Q. What function has holding position?
A. To supply the brake pipe through the feed valve the same as in running position, but hold the locomotive and tender brakes applied.

104. Q. How is the distributing valve release pipe connected with the "ET" equipment?
A. From application chamber exhaust direct to independent brake valve, thence to automatic brake valve.

105. Q. What is accomplished by connecting this pipe through the independent brake valve?
A. When the independent valve is in running position the ports in its rotary make a continuous connection from distributing valve to automatic brake valve, and it provides a means of controlling the locomotive brakes independently.

106. Q. How may the locomotive and tender brakes be released independently of the train brakes?
A. With the independent brake valve by placing same in full release with "ET," equipment and by opening the independent release valve with old standard equipment.

107. Q. What is the function of the lap position of the automatic brake valve.
A. To close all ports.

108. Q. What is the function of the service position?
A. To make graduated service reductions in brake pipe pressure.

109. Q. What is the function of the emergency position?
A. To bring about a rapid and heavy reduction in brake pipe pressure when an emergency application is necessary, also a higher brake cylinder pressure, and with "ET" equipment to supply from the main reservoir possible leakage from the application cylinder of the distributing valve.

110. Q. How is the latter function accomplished?
A. Through small ports in rotary of brake valve open in emergency position, and the copper pipe connecting brake valve to application cylinder of distributing valve.

111. Q. What is the duty of the feed valve?
A. The feed valve controls the brake pipe pressure in running position with G-6 brake valve, and in running and holding positions with the H-6 brake valve.

112. Q. Name the working parts of the feed valve?
A. The supply piston, supply valve, supply valve spring, supply valve piston spring, regulating valve, regulating valve spring, regulating spring, diaphragm and stem.

113. Q. Describe the operation of the feed valve?
A. When the brake valve handle is in running or holding position, air enters the supply valve chamber and moves the supply piston and supply valve over, compressing the piston spring. This movement of the supply valve uncovers the supply port in the seat and air then flows direct to the brake pipe through the ports, also to diaphragm chamber and past the supply piston (which piston is not an air tight fit) past the little regulating valve to the diaphragm chamber; regulating spring is holding the diaphragm over to open the regulating valve.

When the pressure against the diaphragm from the brake pipe exceeds the tension of the heavy regulating spring, the diaphragm yields, and permits the regulating valve spring to close the regulating valve. And as the air flowing past the supply piston, cannot pass the little regulating valve, the pressure will become equal on both sides of the piston when the piston spring will move the piston and slide valve to closed position.

For the feed valve to open up again, a reduction of brake pipe pressure is necessary, which reduces also the pressure in the diaphragm chamber, which allows the regulating spring to unseat the little regulating valve; the air in the chamber between the piston and regulating valve, escapes past the regulating valve to the diaphragm chamber and brake pipe, this will necessarily weaken the pressure against the piston, when main reservoir pressure on the slide valve side will force piston and slide valve over, opening again the supply port to the brake pipe.

114. Q. With brake valve handle in running position, and full main reservoir pressure, what defects in the feed valve will prevent air passing to the brake pipe?

A. The small regulating valve stem too short; supply port or regulating valve port stopped up, or piston stuck in its bushing.

115. Q. If brake pipe and main reservoir pressure become equal, where would you look for the trouble?

A. Leaky feed valve gasket, defective supply (slide) valve or seat, weak piston spring; supply piston becoming air tight from oil and gum, small regulating valve stem too long; the diaphragm leaking with port in regulating spring box stopped up; small regulating valve held from its seat by dirt or scale; also with

the double pressure feed valve, i.e.; the B-6 type having the regulating wheel, if the spring box is screwed up too tightly against the diaphragm ring.

116. Q. How would you test to determine whether the above trouble was from a leaky rotary valve, feed valve or a body gasket?

A. Make a service reduction, move brake valve to lap position, if black hand does not move up, the trouble is in the feed valve, but if the black hand on the gauge moves up, it is the rotary valve or body gasket that is defective.

117. Q. How should the air pressures be adjusted on a locomotive equipped with double feed valve?

A. The double pressure feed valve adjusted to carry 70 and 90 pounds pressure.

118. Q. What defects in feed valve will cause it to fail to maintain maximum pressure on long trains, or at times fail to open up supply port?

A. Supply valve piston too loose a fit, small port between piston and diaphragm chamber stopped up, regulating valve bushing stopped up or the small regulating valve stem too short may cause valve to fail to open.

119. Q. What will cause the feed valve to remain open and overcharge the brake pipe?

A. Too much friction of supply piston, oil or dirt making a tight joint around the piston, preventing pressure from passing behind it, if

piston cap nut joint leaks, also regulating valve cap joint, or the small regulating valve itself leaking.

120. Q. How should test be made for a leaky rotary valve?

A. By placing the brake valve in service position and allowing it to remain there until the brake pipe gauge hand drops to zero; then close the double-heading cock under the brake valve and place the brake valve handle on lap. If a blow starts at the brake pipe exhaust it indicates a leaky rotary valve, as air is passing into the brake pipe above the cut-out cock. If an increase of pressure is noted on the equalizing reservoir gauge hand (i.e., black hand on larger gauge) it indicates a leak past the rotary valve, or the body gasket into chamber D, above the equalizing piston.

121. Q. What would be the effect of a leak into chamber D from the brake pipe? From the main reservoir?

A. Would cause slow rate of reduction of chamber D pressure or fail to unseat the equalizing piston; if unseated it may not reseat. If leakage into chamber D is main reservoir pressure, it would tend to cause the piston to seat too soon; or if a bad leak would prevent equalizing piston raising at all, when service applications are attempted.

122. Q. What would cause the equalizing piston to fail to seat properly after a reduction had been made, particularly when handling a long train?

A. Leakage from the equalizing reservoir or pipe, connection to the brake valve, also copper gauge pipe or tube inside air gauge, the equalizing piston stuck, or some foreign substance on valve seat will prevent discharge valve closing.

123. Q. If the feed valve stuck open and overcharged the brake pipe or stuck shut and would not charge, what would you do to avoid delay and yet be safe?

A. With G-6 brake valve, carry the valve in full release. With "ET" equipment carry the brake valve handle half-way between running and release positions, throttle the compressor to guard against too high brake pressure, or else adjust compressor governor to the brake pipe pressure being carried.

124. Q. In event the pipe breaks between the equalizing reservoir and the automatic brake valve, what would you do to handle train to terminal?

A. Put a blind gasket in "T" fitting on the brake valve and carrying the brake valve handle in running position. Before making application of the brake, close the cut-out cock underneath the brake valve, place the brake valve handle in service position and open cut-out cock until the required reduction is made. To

release brakes, place brake valve in release position, and then open cut-out cock. Another way is to plug brake pipe exhaust fitting and brake carefully from emergency position.

125. Q. How would you test for leakage from main reservoir?

A. With main reservoir charged to maximum pressure, stop the compressor, place the automatic brake valve on lap position. If "ET" equipment, close cut-out cock in main reservoir supply pipe to the distributing valve then note the fall in pressure as shown by the red hand on air gauge.

126. Q. What is meant by excess pressure? Where is it carried and for what purpose?

A. Excess pressure is the amount in pounds pressure in the main reservoir above that in the brake pipe, and auxiliary reservoirs, and is required as driving head to effect a prompt release and recharge of the brake system.

127. Q. In train handling, why should the brake valve handle be moved direct from running position to service position, and not to loaf on lap position previous to making service brake application?

A. Triple valves are sometimes caused to assume emergency from service application, by having the brake valve on lap, several seconds before making the initial reduction, which should not

be done. The brake valve should be left in running position until it is desired to apply the brakes, and then moved directly to service position to make the reduction.

128. Q. Will a sluggish working feed valve have a tendency to produce undesired emergency?

A. Yes, a sluggish working feed valve may tend to cause undesired quick action, by closing and allowing the brake pipe pressure to reduce a few pounds, (either from leakage or equalization taking place in brake pipe) which in turn may cause some of the triple valve pistons to move forward and take up the slack between the shoulders on the piston stem and slide valve. Triple valves in this position cannot respond to a reduction of brake pipe pressure until the difference between brake pipe and auxiliary pressures is sufficient to overcome the entire friction of the triple piston and slide valve without the benefit of the preliminary movement of the piston. In such cases the differential required to move the valve may be greater than the graduating spring can withstand and the valve will go to emergency position.

129. Q. Will overcharging the head brakes tend to produce emergency or undesired quick action?

A. Yes, the same condition as above described may be brought about by overcharging and returning brake valve to running position, and

neglecting the "kick-off" movement which is necessary after a train brake releases.

130. Q. How to a great extent can undesired quick action be prevented in event of a sluggish working feed valve or careless overcharge?

A. This may be overcome by exercising good judgment by first moving brake valve to full release (a "kick-off") position for an instant, just before beginning a brake application, then move to service position, the object being to start a slight release wave through the train to ensure the triple valve being in release position when the application begins.

131. Q. What will cause an intermittent blow at the brake pipe exhaust, with brake valve handle in lap position?

A. A leak from the equalizing reservoir or its connections.

132. Q. With handle of brake valve in service position and no brake pipe exhaust can be obtained, where is the trouble?

A. The preliminary exhaust port might be stopped up, leaky body gasket; brake pipe exhaust fitting stopped up, or the equalizing discharge valve piston stuck.

"ET" EQUIPMENT

133. Q. Name the essential parts of the "ET" brake equipment?

A. Air compressor, main reservoir, governor, feed valve, reducing valve, automatic brake (H-6) valve, equalizing reservoir, independent brake valve, distributing valve and double chamber reservoir, two duplex air gauges, dead engine feature, choke fitting, locomotive brake cylinders, necessary pipe, cocks, hose and fittings.

134. Q. Name the pipe connections to the distributing valve?

A. Top pipe left side (facing the distributing valve), is the main reservoir supply pipe, bottom (copper) pipe left side is the release pipe, the middle (copper) pipe left side is the application cylinder pipe. On the right side, the top pipe is the brake cylinder pipe, the bottom pipe is the branch from the brake pipe.

135. Q. What are the principal parts of the distributing valve and reservoir?

A. Equalizing piston and slide valves, application piston and slide valves, pressure chamber, application chamber and safety valve.

136. Q. From where do the engine brake cylinders receive their air supply ("ET" equipment)?

A. From the main reservoir.

137. Q. What controls the pressure admitted to the brake cylinders?

A. The pressure applied to application piston and is limited by the safety valve.

138. Q. Where does the pressure applied to the application piston come from during an automatic application?

A. From the pressure chamber.

139. Q. What advantage has this system over the old automatic A-1-Type?

A. Brake cylinder leakage is automatically supplied, variations in piston travel does not effect the brake cylinder pressure, as proper cylinder pressure is had regardless of piston travel, also increased braking power in emergency applications.

140. Q. How many ¾-inch pipe connections are there to the distributing valve reservoir and what are they?

A. Three. A branch from the brake pipe, a brake cylinder pipe, and a supply pipe from the main reservoir.

141. Q. How many ½-inch copper pipe connections are there in the distributing reservoir?

A. Two. The release pipe connected to exhaust of application chamber, and the application cylinder pipe connected to the application cylinder direct.

142. Q. How can the copper pipe connecting the distributing valve reservoir be identified?

A. By raised letters on the reservoirs near the pipe connections, or the upper pipe, is the application cylinder pipe, and the lower one the release pipe.

145. Q. How are the other pipe connections marked on the distributing valve reservoir?

A. The brake pipe is marked "B P." The brake cylinder pipe is marked "C Y L S." The main reservoir supply pipe is marked "M R."

144. Q. Should the application and release pipe at distributing valve be accidently coupled up wrong, or crossed, what effect would this have?

A. The locomotive brakes may operate alright at times, when again same cannot be operated with independent brake valve, this being the case, should the equalizing portion of the distributing valve move to lap position, should this occur, the engineer could not release driver brakes with independent brake valve.

145. Q. How would you test for such a defect?

A. Apply the automatic brake, then if the brake cannot be released with the independent valve while automatic brake valve is on lap, it indicates crossed pipes.

146. Q. What is the duty of the distributing valve?

A. To automatically apply and release the engine brake and hold brake cylinder pressure constant against ordinary brake cylinder leakage, or variation of piston travel.

147. Q. Name the two operating portions in the distributing valve?

A. Equalizing portion and the application portion.

148. Q. Are both portions, brought into use during automatic applications of the brake? With the independent application?

A. Both portions are used in automatic brake application, but only one portion, i. e., the application (upper) portion during independent brake application.

149. Q. What are the operative parts in the distributing valve?

A. Application piston, application valve, exhaust valve and application piston graduating spring, comprises the application portion. The equalizing piston, equalizing slide valve, and graduating valve, comprise the equalizing portion.

150. Q. What can cause the locomotive brake ("ET" equipment) cylinder pressure to build up during a partial automatic brake application?

A. This will be caused by brake pipe leakage, air leaking into the application cylinder of the distributing valve. Such leaks may occur past the independent or automatic brake valve rotary, equalizing slide valve, application piston packing leather, the distributing valve gasket or brake valve gasket.

151. Q. What will cause an intermittent blow at brake cylinder exhaust port of distributing valve when brake is applied?

A. Application valve leaking.

152. Q. How would you tell if the exhaust valve was leaking?

A. If exhaust valve leaks there will be a steady blow at exhaust port when brake is applied.

153. Q. If the application cylinder pipe (upper copper pipe) of the "ET" equipment leaks, what should be done?

A. Proceed; the brake on locomotive and tender will leak off. Use the independent brake in application position until repairs can be made.

154. Q. If the brake releases after an independent application, what would cause it?

A. Release pipe broken or leaking, application cylinder pipe leaking, or application cylinder cap gasket.

155. Q. How is the brake applied with the Westinghouse independent brake valve? "ET" equipment?

A. By admitting air direct from the main reservoir through the reducing valve to the application cylinder of the distributing valve.

156. Q. At what pressure should the independent reducing valve be set?

A. Forty-five (45) pounds.

157. Q. Can the locomotive brake on a dead engine be controlled with the independent brake valve, the same as on a live engine?

A. Yes, if it becomes necessary.

158. Q. When the dead engine feature is being used on a locomotive, in what position must the automatic and independent brake valve handles be carried?

A. Both in running position.

159. Q. What should be the position of the double-heading cock under the automatic brake valve?

A. Closed.

160. Q. Is it sometimes desirable to keep the braking power of a locomotive below the standard?

A. Yes, when there is no water in the boiler.

161. Q. How is this done?

A. By adjusting the safety valve on the distributing valve to the desired amount, i. e., not less than 25, nor more than 30 pounds.

162. Q. How is the pressure in application cylinder prevented from equalizing with main reservoir?

A. By safety valve attached to distributing valve.

163. Q. At what pressure should the safety valve be adjusted for general service?

A. Sixty-eight (68) pounds.

164. Q. With "ET" equipment, where would you look for the trouble if the locomotive brakes failed to apply with the automatic brake valve?

A. If this occurs during an automatic application of the brake, it may be due to the pressure chamber not charged or leaking. Leakage from the application chamber or cylinder, either past the drain plug, cylinder cap

gasket, application piston packing leather, or in the application cylinder pipe. Safety valve leaking, a bent equalizing piston or defective equalizing piston packing ring. Moisture collecting in winter months may freeze and prevent proper operation of the distributing valve parts. See that the cutout cock in main reservoir supply pipe to distributing valve is open, also cocks leading to brake cylinders.

165. Q. Where would you look for the trouble if the independent brake "ET" equipment did not apply?

A. If the brakes apply with the automatic brake valve, but not with the independent brake valve, it may be due to the independent reducing regulating nut entirely unscrewed, or the reducing valve dirty, gummed up so that it won't open, a stopped up application cylinder pipe, application ports in the independent brake valve stopped up, or distributing valve application or release pipe leaking.

166. Q. What would cause brakes to fail to release "ET" equipment?

A. If this occurs after an automatic brake application, and the automatic valve moved to running position, may be due to failure to move equalizing portion of distributing valve to release position on account of a light application, the slow increase of brake pipe pressure, and possibly leaky equalizing piston packing

ring, improper position of the independent brake valve handle, release pipe stopped up, failure of application piston to move to release position. If brake cannot be released with the independent brake valve in full release position, but can be released with the independent and automatic valve in running position, it would indicate an obstruction in the application cylinder pipe or ports in the independent brake valve.

167. Q. What will cause brakes on engine and tender "ET" equipment to leak off after an automatic application?

A. If the brakes leak off after the automatic brake valve has been returned from service position to lap, it indicates application cylinder leakage which can occur at the drain plug in bottom of reservoir, cylinder cap gasket, application cylinder pipe, independent rotary valve, or independent pipe bracket gasket, leaking from application cylinder pipe to atmosphere. If the piping to brake cylinders should leak, or brake cylinder pressure head gasket, or the exhaust valve in the distributing valve, the brake will likely leak off, providing with any of the above cylinder pressure leaks that the application piston packing leather leaks also. A safety valve leak cannot leak the brake off after equalizing piston and its valves return to lap position unless the graduating valve is

leaking from application cylinder to the safety valve. If the brakes apply with automatic valve and hold properly on lap, but leak off when brake valve is moved to release or holding position, it can only be caused by the distributing valve release pipe leaking, or else the safety valve leaking.

168. Q. What will cause the locomotive brake to leak off after an independent brake application?

A. If the brakes apply properly with the independent brake valve but leak off after it is returned to lap, it is due to application cylinder leakage which may occur at any of the places mentioned previously, except the section of the distributing valve release pipe between the two brake valves; and if the brakes hold with the automatic application, but will not with the independent application, it must be leakage in the distributing valve release pipe or safety valve.

169. Q. Where would you test for leakage from the application chamber and cylinder?

A. To test, place the independent brake valve in application position and leave it there, this will keep air in the application chamber and cylinder, also the pipes leading from the distributing valve to the brake valves, the only pipe not filled with air at this time is the small section of release pipe between the two brake valves. To test for leakage, the proper way

is to use soapsuds, as faint leaks cannot be detected otherwise. If unable to locate leaks in this manner, inspect the two copper pipes to see that they are not worn through by rubbing against some metal part such as cab deck.

170. Q. If, with the locomotive brakes applied, it was observed that the compressor was laboring hard to maintain pressure, and the red hand on the air gauge indicates a decided fall in main reservoir pressure, what would cause this, and what should be done?

A. This would be due to a brake cylinder head gasket blowing out, or a broken brake cylinder pipe, and as air is being supplied direct from the main reservoir to the brake cylinders, it would necessarily effect it, according to the size of the leak. If this should happen on the line, the engineman can prevent this waste of air by holding the independent brake valve in release position during an automatic brake application, thereby preventing the application portion of the distributing valve from moving to supply air to the brake cylinders. At the first stop, close cut-out cock to the brake cylinder effected.

171. Q. If the application cylinder 'pipe of the "ET" equipment leaks, what should be done?

A. Proceed. The automatic brake on the locomotive and tender will leak off, use the independent brake instead.

172. Q. What are the parts composing the dead engine feature—"ET" equipment?

A. A ⅜-inch pipe connecting the brake pipe and the main reservoir pipe, a combined strainer and check valve with a choke fitting and a ⅜-inch cut-out cock.

173. Q. What is the purpose of the dead engine feature of the "ET" equipment?

A. To enable the compressor on a live engine to charge the main reservoir on a dead engine so that the brake on the dead engine may be operated with the other brakes in the train.

174. Q. How is this done?

A. Air from main reservoir of the live engine passes through the brake pipe and dead engine feature to the main reservoirs of the dead engine, when the ⅜-inch cut-out cock on dead engine feature is opened. The cut-out cock under automatic brake valve closed, and both brake valves must be in running position.

175. Q. When is this apparatus used?

A. Only when air compressor on the locomotive is inoperative.

176. Q. Should the cut-out cock on dead engine feature always be closed *except* when the compressor is inoperative?

A. Yes.

177. Q. How can the maximum brake cylinder pressure be regulated on a dead engine?

A. By adjustment of the safety valve on the distributing valve.

BRAKE PIPE AND CONNECTIONS

178. Q. What air brake equipment is necessary on cars?
A. Angle cocks and cut-out cock, hose and couplings, brake cylinders, auxiliary reservoir, triple valve, brake pipe strainer or centrifugal dirt collector, pressure retaining valve, and on passenger cars and cabooses, a conductor's valve.

179. Q. Why does the compressed air not enter directly into the brake cylinder from the brake pipe?
A. Because the triple valve used with the automatic brake prevents the air from entering directly from the brake pipe to the brake cylinder.

180. Q. What is the use of the angle cocks?
A. They are used to close the brake pipes at both sides of any hose coupling which is to be parted, as when the train is cut in two, and to close the brake pipe at the end of the train.

181. Q. Why is it necessary to close the brake pipe on both sides of the hose couplings before it is parted?
A. To prevent the escape of air from the brake pipe, which would apply the brakes.

182. Q. How must the hose coupling be parted when it is necessary to do so, and why?
A. Must be by hand, to prevent the possibility of injury to the hose and the rubber gasket in the coupling.

183. Q. In coupling or uncoupling the hose between cars, what must be done if there is ice on the couplings?

A. The ice must first be removed and the coupling thawed out, so as to prevent injury to the rubber gaskets in uncoupling, and to ensure tight joints in coupling the hose.

184. Q. What must be done with the hose coupling which is not coupled up, such as the rear hose of a passenger train car, or any hose on a passenger car which is standing or running but not in use?

A. It must be coupled to the dummy coupling.

185. Q. What pressure should be carried in the brake pipe and auxiliary reservoir?

A. The authorized pressure as per standard instructions.

186. Q. Why should be authorized pressure be maintained?

A. Because this pressure is necessary to get the full braking force which each car is capable of using and if it is exceeded, there will be danger of sliding the wheels.

187. Q. Is it important to keep all the air brake apparatus tight and free from leaks?

A. Yes, in order to get proper service from the air brakes, and to prevent the waste of air, and also to prevent the brakes applying automatically by reason of leaks in the brake pipe.

188. Q. Is it important to know that the brake pipe is open throughout the train and closed at rear end before starting out?

A. Yes, this is very important.

189. Q. Why is this very important?

A. Because if any cock in the brake pipe was closed, all the brakes back of the cock, which if closed, would be inoperative.

190. Q. How can you ascertain that the angle cocks are all open when the train is made up?

A. By testing the brakes; i. e., by applying and releasing them from the locomotive and observing whether they all operate.

191. Q. How does handle of the cut-out cock in cross-over pipe stand when open?

A. Crosswise (at right angle) with pipe, and groove in top of plug, parallel, or in line with the pipe.

192. Q. How does the handle and groove stand when the cock is closed and the brake is cut-out?

A. Straight (parallel) with crossover pipe, and the groove at right angles, or crosswise the pipe.

193. Q. How is the brake pipe closed at the rear end of train?

A. By closing the angle cock in brake pipe and signal pipes at ends of car.

194. Q. How many kinds of cocks in brake and signal pipes at ends of car?

A. Two.

195. Q. Describe each, and give position of the handle and groove for open and closed position in each case.

A. The older form of brake pipe cocks was a straight cut-out cock located in the brake pipe, close to the hose connection: The handle stands crosswise (at right angle) with pipe when it is open and straight (parallel) to the pipe when closed. It is now used principally on the signal and front end of brake pipe of locomotive. The other form of cock used on the brake pipe is an angle cock placed on the end of the brake pipe and hose screwed into it. The handle of the angle cock stands straight (parallel) with the pipe when it is open, and crosswise (at right angles) to the pipe when it is closed. The groove in top of plug is a guide to tell whether opened or closed.

196. Q. What is the difference between cutting the air out of a car and cutting it out from a brake?

A. Closing the angle cock at the end next the engine cuts out that car and all behind it. Closing the cock between brake pipe and triple valve cuts out that brake only and allows all the rest to operate.

TRIPLE VALVES, AUXILIARY RESERVOIRS AND BRAKE CYLINDERS

197. Q. Name the different types of triple valves used on freight cars?

A. On eight-inch brake cylinders—Westinghouse type: H-1 and K-1—New York, F-1, K-3, K-5; GN-1. On ten-inch brake cylinders—Westinghouse type: H-2 and K-2. New York, H-1—K-4, K-6 and GN-2.

Note: K-1 and K-2 are the recognized ARA standard valves.

198. Q. On passenger cars?

A. The Westinghouse type: (F-27) P-1 on ten-inch cylinders. The Westinghouse (F-29) P-2; is used on twelve, fourteen, and sixteen inch cylinders.

199. Q. What other types of brake equipment are used on modern heavy passenger cars?

A. The PC (passenger control) and the UC (universal control) equipment, LN and PS equipment.

200. Q. What three things does the triple valve do?

A. Charges the auxiliary reservoir, applies and releases the brakes.

201. Q. At what rate does an auxiliary reservoir charge on a freight car?

A. Approximately 1 pound per second.

202. Q. Why does it take so long to charge?
A. On account of the feed groove in the triple valve being so small.

203. Q. Can a 75-car train be charged as quickly as a 25-car train?
A. No.

204. Q. What causes the automatic brake to apply?
A. Reducing the pressure in brake pipe below the auxiliary reservoir pressure.

205. Q. What causes the automatic brake to release?
A. Increasing the brake pipe pressure above the auxiliary reservoir pressure, or reducing the auxiliary reservoir pressure below the brake pipe pressure.

206. Q. How does the brake cylinder piston get back when the brakes are released?
A. There is a spring around the piston rod which is compressed when the brakes are applied and when the air is allowed to escape from the brake cylinder, this spring reacts and pushes the piston back.

207. Q. Name the working parts of the plain triple valve?
A. Triple piston, slide and graduating valves.

208. Q. Are the same parts contained in quick action triple valves?
A. Yes, and in addition, an emergency valve, piston and check valve.

209. Q. Are all valves fastened to the triple piston?
A. No, only slide and graduating valves.

210. Q. What is the duty of triple piston?
A. To operate both slide and graduating valves, and open and close the feed grooves and ports.

211. Q. What moves the triple piston?
A. The difference of air pressure on either side of triple piston.

212. Q. What two pressures are carried on both sides of triple piston?
A. Brake pipe pressure on one side, and auxiliary reservoir pressure on the other.

213. Q. To have triples respond promptly on reduction, how must these pressures stand?
A. Equal.

214. Q. With 70 pounds brake pipe pressure what service reduction will fully apply brake?
A. Twenty pounds.

215 Q. Why does 20 pounds reduction from the brake pipe fully apply the brakes?
A. It causes the auxiliary reservoir and brake cylinder pressure to equalize.

216. Q. How much pressure is there in the auxiliary reservoir and brake cylinder when equalized?
A. Fifty (50) pounds.

217. Q. Why does 20 pounds from the auxiliary reservoir make 50 pounds in the brake cylinder?
A. Ordinarily a 20-pound service reduction will

bring about equalization or full service, because the auxiliary reservoir is so proportioned to the brake cylinder that with *eight inch piston travel* they will equalize at 50 pounds from the initial pressure of 70 pounds in the auxiliary reservoir, but if the piston travel is longer than eight inches it will require more than 20 pounds brake pipe reduction to bring about equalization and the equalized pressure will be lower; while if the piston travel is shorter than eight inches, equalization can be obtained with less than 20 pounds brake pipe reduction and the resultant pressure would be higher.

Therefore, it is the duty of the triple valve in service applications to weigh the air from the auxiliary reservoir to the brake cylinder in the same proportion in which it is drawn from the brake pipe. It should be understood that 20 pounds drawn from the brake pipe will cause 20 pounds to pass from the auxiliary to the brake cylinder and will (because of the small volume of the brake cylinder as compared to the larger volume of the auxiliary reservoir) develop a pressure of 50 pounds in the brake cylinder.

218. Q. What kind of a reduction should be made from the brake pipe to get a service application?
A. A gradual reduction.

219. Q. Can the brakes be applied so as to get only a portion of this pounds pressure in the brake cylinder, and how?

A. Yes, they can be so applied by making limited reductions of brake pipe pressure.

220. Q. What kind of a reduction should be made from the brake pipe to get quick action?

A. A quick reduction.

221. Q. What is the difference between the service and quick action with the quick action triple valves?

A. In service, air is admitted to the brake cylinder from the auxiliary reservoir only, while in emergency, air is admitted to the brake cylinder from both brake pipe and auxiliary reservoir with Westinghouse type of triple valves. With the older type of New York triples brake pipe air is vented to the atmosphere.

222. Q. Why is brake pipe air admitted to the brake cylinder?

A. To increase the brake cylinder pressure and secure local brake pipe reduction.

223. Q. Why is the local brake pipe reduction needed?

A. To secure quick action of the next triple, ensuing serial quick action, throughout the train.

224. Q. What additional features has the "K" type triple valve over the old standard, quick action triple?

A. Quick service, retarded release and uniform recharge.

225. Q. How is quick service obtained?
A. By venting a small amount of brake pipe pressure to the brake cylinder in a service application.

226. Q. How is retarded release obtained?
A. By a considerable increase of brake pipe pressure over the auxiliary reservoir pressure, which moves the triple piston to a position restricting the triple value exhaust.

227. Q. When and how will the retarded recharge be obtained?
A. At the same time and under the same conditions as retarded release.

228. Q. How far back from the locomotive can the retarded release be obtained?
A. About 25 or 30 cars.

229. Q. Why is the recharge retarded?
A. To prevent overcharging the head auxiliary reservoirs in the train and thereby permitting a heavier flow of air towards the rear of train.

230. Q. What equipment is necessary on passenger cars for the complete Westinghouse L. N. schedule, or the New York P. S. brake?
A. Brake cylinder, L type triple valve for Westinghouse, or PS for New York. Auxiliary

and supplementary reservoirs, angle cocks and cut-out cock, hose, dirt collector and retaining valve.

231. Q. What equipment have we on our passenger and baggage cars which are not equipped with "P" type triple valves?

A. The New York type "PS" which is similar to the Westinghouse LN.

232. Q. How is the supplementary reservoir charged?

A. From the brake pipe, through the triple valve.

233. Q. What is the pressure in the supplementary reservoir used for?

A. Quick recharge, and high pressure in emergency.

234. Q. How much larger is the supplementary reservoir than the auxiliary reservoir?

A. From 2 to 2½ times as large, depending on the size of brake cylinder used, and braking power desired for the weight of car.

235. Q. Is the supplementary reservoir pressure used during the service application?

A. No, it is cut off by the triple valve.

236. Q. How is a quick recharge accomplished?

A. When the brake pipe pressure is increased enough to move triple valve to release position, a port is opened from the supplementary to the auxiliary reservoir, which allows the supplementary reservoir pressure to increase that in the auxiliary.

237. Q. What are the advantages of the quick recharge?

A. *First:* After full release of brakes, practically full braking power is available at once.

Second: After a partial release and recharge, auxiliary and brake pipe pressures are equal, ensuring a prompt response to a reduction of brake pipe pressure.

238. Q. Explain the high pressure emergency feature of the P. S. or L. N. equipment?

A. When triple valve is in emergency position, direct communication is open from the supplementary to auxiliary reservoir and the brake cylinder, the combined capacity of both reservoirs will equalize with the brake cylinder at a high pressure.

239. Q. Is the "P. S." triple valve interchangeable with any other type of triple valve?

A. Yes, the Westinghouse type "L" can be substituted.

240. Q. What type of equipment has the New York P. S. brake?

A. On home line passenger equipment cars only.

241. Q. How can it be distinguished from other air brake equipment on home line passenger cars?

A. It is of the pipeless type, fastened directly to a triple valve bracket, and not bolted to the brake cylinder head, as with the "P" type triple valve.

242. Q. What else besides the triple valve is attached to the triple valve bracket?

A. The vent valve, also the piping which connects the brake pipe, the brake cylinder, the supplementary reservoir and the auxiliary reservoir.

243. Q. With the P. S. brake should the vent valve which is bolted to the triple valve bracket become defective, or cause a blow at the exhaust, what should you do?

A. Close the exhaust port with a one-half inch pipe plug, or a wooden plug driven in the opening and secured.

244. Q. Is it necessary to cut the brake out on account of a defect in the vent valve?

A. This will not interfere with the service application, nor the high emergency brake cylinder pressure.

245. Q. With the P. S. type brake does it require different size triple valves for the various sizes in brake cylinders?

A. No. Triple valve is so constructed that the one size may be used for any given size brake cylinder by simply changing the feed port plug.

246. Q. How are the feed port plugs of proper size determined for a given size brake cylinder?

A. They are marked thus: 12-14-16 or 18, indicating the 12-14-16- or 18-inch cylinders respectively.

247. Q. What type of brake is common standard on Pullman cars?
A. The "UC" or Universal Control.

248. Q. Is a triple valve used with the "UC" equipment?
A. No.

249. Q. What takes the place of the triple valve?
A. The Universal valve.

250. Q. How many reservoirs are used with the "UC" equipment? A. Three, except on very heavy cars, weighing over 150,000 pounds, then two emergency reservoirs are necessary.

251. Q. Name the reservoirs?
A. Auxiliary reservoir, service reservoir and emergency reservoir.

252. Q. Where does the air for the brake cylinder come from in a service application?
A. From the auxiliary and service reservoirs.

253. Q. Where does the air for the brake cylinder come from in an emergency application?
A. From the auxiliary, service and emergency reservoirs.

254. Q. Universal valve is made up of how many parts?
A. It is made up of three parts, the pipe bracket which is permanently located to the car body, the equalizing portion which is fastened to the one side of the pipe bracket and the emergency portion fastened to the other side of the pipe bracket.

255. Q. What is the equalizing portion used for?
A. To charge the reservoirs and bring about a service application of the brake.

256 Q. What is the emergency portion used for?
A. To bring about an emergency application of the brakes.

257. Q. If the universal value becomes defective, should the internal parts be removed for examination?
A. No. Never remove any of the operating parts of the "UC" valve while it is on the car. If any one portion (*i. e.*, the equalizing portion or emergency portion) is not working properly, remove that portion, send it to the air brake repair room, and apply a repaired and tested portion.

258. Q. How should a brake be cut out due to a defective "UC" valve?
A. Close the cut-out cock in the branch pipe, also close the one in the brake cylinder pipe. It is not necessary to drain the reservoir.

259. Q. Would any higher brake cylinder pressure develop from a ten-pound brake pipe reduction carrying 90 pounds brake pipe pressure than would be the case carrying 70 pounds brake pipe pressure?
A. No.

260 Q. When necessary to release the brake on a passenger car having "UC" equipment, what would you do?

A. Open the drain cocks on the auxiliary and emergency reservoirs, leaving them open until the brake piston has entirely moved into release, then close drain cocks.

RETAINING VALVES

261. Q. What is the pressure retaining valve, and what is its use?

A. The pressure retaining valve is a small valve placed at the end of the pipe from the triple valve, through which the exhaust takes place from the brake cylinder. It is used to retard the brake release on heavy grades and hold the brake partially applied, so as to allow more time for the enginemen to recharge the auxiliary reservoirs.

262. Q. What is the function of a retaining valve?

A. To hold a certain pressure in brake cylinder, varied according to type of retainer, thus keeping brake applied sufficiently, owing to the slow blow down of pressure, thereby allowing a longer period for recharging auxiliary reservoirs.

263. Q. To what part of triple is retainer pipe attached?

A. To the exhaust port, making an exhaust passage from triple valve to retainer.

264. Q. Where are they used?

A. On descending grades.

265. Q. How many kinds of retaining valves are there?
A. Four, the 15 pound; the 10-20 pound; 15-30 pound; and 25-50 pound retaining valves.

266. Q. How many positions has the 15-pound retaining valve?
A. Two, handle down or parallel to the pipe when the retaining valve is not in use. Horizontal, or up at right angles, to the pipe when the retaining valve is in use, holding 15 pounds in the brake cylinder.

267. Q. How many positions has the 10-20, 15-30 or 25-50 type of retaining valve?
A. Three. Handle down or parallel to pipe when not in use, horizontal or at right angles to the pipe when holding 10, 15 or 25 pounds in the brake cylinder. Midway between horizontal and vertical or at any angle of 45 degrees, when holding either 20, 30 or 50 pounds in the brake cylinder.

268 Q. What is the size of the small exhaust port in the pressure retaining valve that is used when the handle is turned up?
A. One-sixteenth of an inch for freight brake retaining valves. On passenger car retainers it is one-eighth inch in diameter.

269. Q. If air pressure is found blowing through a retaining valve, should it be plugged up?
A. No, for that would prevent the brake releasing. The defect is in the triple valve, and not the retainer.

270. Q. Do retainers hold air in the brake cylinders before or after brake is set?

A. After brake is set and released.

271. Q. If the retaining valve pipe is broken or retaining valve is gone, should the brake be cut out?

A. No, only the retaining feature would be lost.

272. Q. What does a heavy blow at the exhaust of retaining valve indicate?

A. A defective triple valve, usually an emergency valve leaking.

273. Q. What should be done?

A. Cut out cock in crossover pipe should be closed and triple valve tapped lightly, and the cut-out cock then opened quickly. If the blow at the retaining valve does not cease after this treatment the brake should be cut out and air brake defect card (form 1029) applied to the car and marked, "triple valve leaks at exhaust."

274. Q. How would you proceed to test the retaining valves in a train?

A. At terminals, and other points where it may be necessary to test retainers in train, the following method should be carried out:

The retainers should all be turned up and the first brake application should be made with a 20-pound reduction in brake pipe pressure. As soon as the brake pipe exhaust

ceases the brake valve should immediately be placed in release position and returned to running position again in time to prevent overcharging the brake pipe. Inspectors or others making the test should note the time the release is made, and in two (2) minutes (consult your watch) after the release, start turning down retainer valve handles noting the discharge of air therefrom, using one minute in this operation, then stopping enroute, as in three (3) minutes' time the engineman should again apply the brake and release as before as soon as the brake pipe exhaust ceases, in two minutes' time after the release the inspectors will proceed as before from the point at which they left off and continue the test for another minute, repeating this operation until all retainers have been tested.

The engineer should sound the whistle for each application and release so inspectors may know when to begin "taking time" on retainers. However, inspectors can easily tell each time brakes are applied and released from observation.

The above method will give 2 minutes' test time on the retainers holding the brake cylinder pressure and one minute for inspecting after the test period has elapsed and before the next application. All retaining valves that give a strong blast of air when handle is

turned down will be considered good brakes; those that do not blow at all will be considered ineffective brakes for grade work.

The retainers to be efficient must hold the brake shoes firmly against the wheels for 2 minutes after triple valve has gone to release position.

When the tests are made from a yard test plant, the man operating the brake valve should proceed as above, using a flag or lamp signal to indicate the brake application or release.

TRAINMEN AND INSPECTORS

275. Q. How and why should the brake pipe always be blown out thoroughly before connecting up to the train?

A. By opening the angle cock at the rear end of the tender and allowing the air from the main reservoir to blow through. This blows out the oil, water, scale, etc., which may accumulate in the pipe and which would be blown back into the brake pipe and triple valves, if not removed before coupling to the train. In cold freezing weather this should never be neglected, brake pipe should be thoroughly blown out before engine is taken from roundhouse, also when engine is detached from train, after taking water, before coupling up again.

276. Q. If the brake sticks upon a freight car so that the engineman cannot release it, how should it be released?

A. By opening the release valve in the auxiliary reservoir, holding it open until air begins to escape from the retaining valve, then close it again.

277. Q. When there is pressure in the brake pipe, how long should release valve be held open to release the brake?

A. Until the brake starts to release.

278. Q. When there is no pressure in the brake pipe, how long should the release valve be held open?

A. Until the brake is fully released.

279. Q. If the locomotive is coupled to the train and the air brake on a car does not release when all pressure is bled from auxiliary, where would you locate the trouble?

A. Retaining valve handle may be turned up, if not, the triple valve exhaust, retainer pipe or retainer is stopped up.

280. Q. How can the brake be released?

A. *First:* Remove the plug in the exhaust port on the opposite side of the triple valve, or disconnect the retainer pipe.

Second: Should air exhaust from brake cylinder through triple valve all right, examine the foundation brake to see if rods or levers are

binding from being fouled, also note brake beam hangers.

Third: Close cut-out cock in branch pipe, bleed the brake off and apply air brake defect card (from 1029) marked "brake will not release."

281. Q. If a brake repeatedly fails to release from the locomotive, what should be done?

A. Cut out the brake and apply an air brake defect card (form 1029) marked "brake sticks."

282. Q. If a brake with auxiliary reservoir charged, fails, to apply or remain applied when a brake pipe reduction is made, what is the cause?

A. Leaky brake cylinder packing, auxiliary reservoir induction pipe leaking on detached equipment, release valves leaking, or brake cylinder pressure head gasket leaking.

283. Q. Should the brake be cut out for above defect?

A. No, but apply an air brake defect card (form 1029) marked "brake leaks off."

284. Q. What defect will cause a blow at the side vent ports of the old type New York triple valves?

A. The brake cylinder check valve, the emergency valve or vent valve.

285. Q. How may the defective valve be located?

A. If a check valve is leaking the blow will occur only when brake is set, an emergency valve, or vent valve, will if leaking cause a blow whether brake is applied or released.

286. Q. How can you tell if a vent valve or an emergency valve?

A. Close cut-out cock in branch pipe. If vent valve is leaking it will immediately reduce brake pipe pressure and cause the brakes to apply. If brake does not apply, it is an emergency valve leaking and will, when brake is applied, cause same to release.

287. Q. If a vent valve leaking, can it sometimes be stopped, how?

A. By tapping on front cap, or cut brake out, bleed auxiliary reservoir and cut in again. If blow does not stop, cut brake out and apply defect card (form 1029).

288. Q. Will such a defect as vent valve leaking have any other effect on train brakes?

A. Yes, after an emergency application of the brakes, this valve sometimes sticks open and will cause a heavy brake pipe leak. That particular brake when applied will not release, besides will tend to cause brakes to stick in the rear of it owing to brake pipe air escaping to atmosphere, and not raising sufficiently rapid to release them.

289. Q. What will cause a blow at exhaust port (or retainer exhaust) of a Westinghouse triple valve?

A. Generally an emergency valve leaking due to dirt on rubber seat, possibly valve may be held off seat by a bent emergency valve stem.